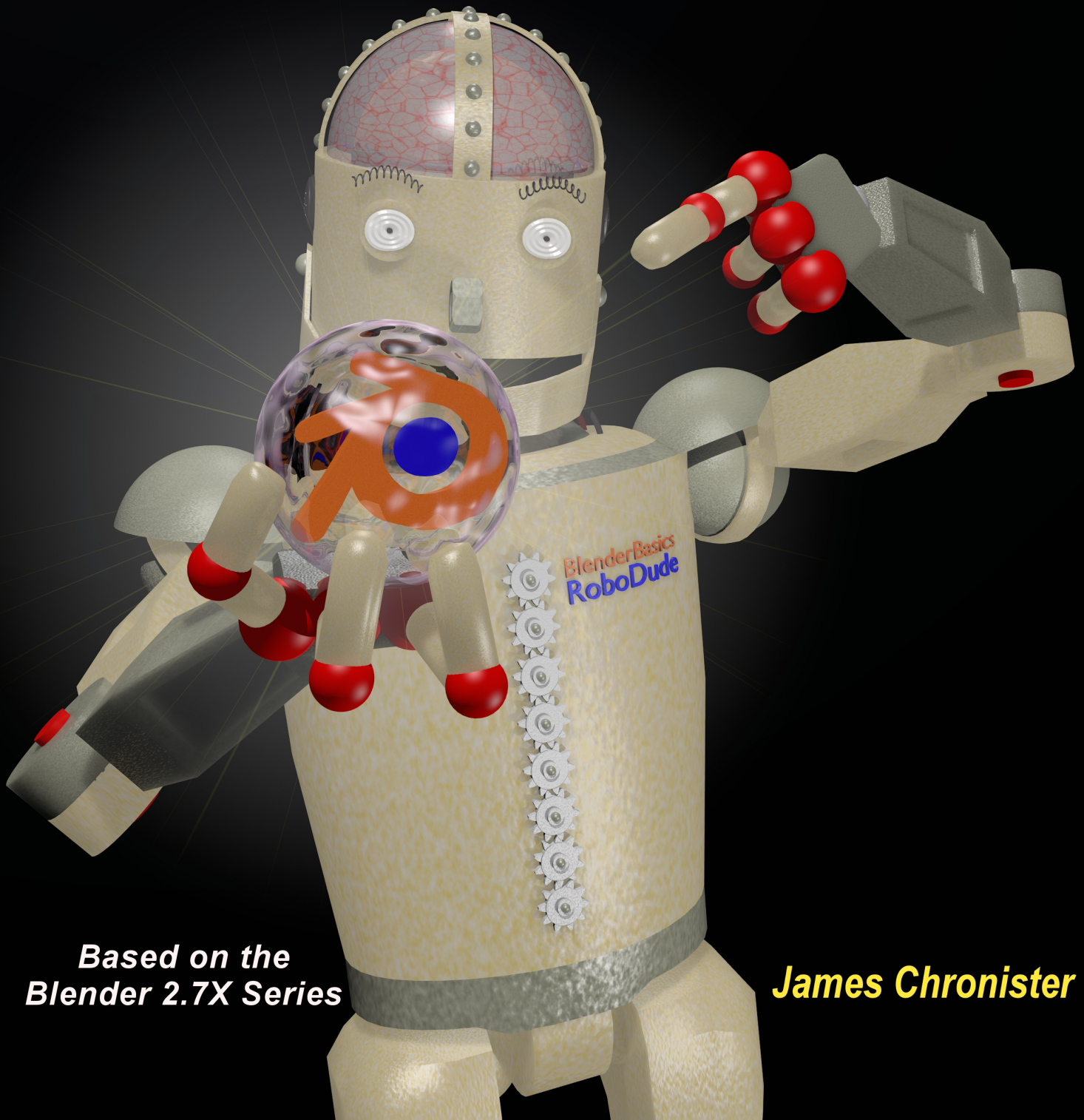# Blender Basics
Classroom Tutorial Book
5th Edition

Based on the Blender 2.7X Series

James Chronister

BlenderBasics
RoboDude

You can now find video tutorials for Blender Basics on line for each chapter. Visit:

http://www.cdschools.org/blenderbasics

Look for the video link on the page to take you to the YouTube channel.

Information regarding the Blender program and development can be found at www.blender.org. Blender users can also find information on how to use the program at www.blenderartists.org. Daily Blender news and tutorial links can be found at www.blendernation.com.

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Performance Tasks

About Blender

How can Blender be free?

People usually associate freeware software with the terms "bad", "with limited features" or just a "demo". Blender is fully functional. It works as an open-sourced, community development program where people from around the world contribute to its success. Blender is a rendering\animation\game development open-sourced freeware program maintained by the Blender Foundation and can be downloaded, free of charge, from www.blender.org. The goal of the foundation can be summarized as follows:

"The Blender Foundation is an independent organization (a Dutch "stichting"), acting as a non-profit public benefit corporation, with the following goals:

1. *To establish services for active users and developers of Blender.*

2. *To maintain and improve the current Blender product via a public accessible source code system under the GNU GPL license.*

3. *To establish funding or revenue mechanisms that serve the foundation's goals and cover the foundation's expenses.*

4. *To give the worldwide Internet community access to 3D technology in general, with Blender as a core.*

Blender website (blender.org)

Blender can be a difficult program to learn with limitless possibilities. What do you teach in the time you have to teach? That's a tough question because you can't teach it all. This tutorial book is designed to get you up and running in the basics of creating objects and scenes and animating. The best advice I can give you about learning this program is *Don't Give Up*! **All** rendering and animation programs have a tough learning curve. After a few weeks, things get easier. This tutorial has been developed to be used in conjunction with daily lesson planning and demonstrations. Because of this, some areas of Blender have not been described as fully as they could be. If you are using this guide as a stand-alone teaching or "self-help" tool, you may need to seek additional help from reputable places like www.blender.org and www.blenderartists.org to make sense of things. These sites give you access to help forums and tutorials. *There are literally thousands of Blender users world-wide that browse the forums to give and get advice*. Make use of that vast knowledge base!

Version Information:

The current release at the time of this printing is **version 2.78**. Since Blender is developed by a worldwide pool of individuals giving freely of their time, releases happen often.

New for this edition:

While most of the activities here use the classic render engine due to classroom time constraints (*cycles rendering is very time intensive*), a unit (and more) has been added for the cycles render engine. There are also new challenge tasks for those students that are looking for extra, or alternate, activities. Reference to education standards, reflective writing, motion tracking, and 3D printing have also been added.

Rendering and Animation

Rendering and Animation Basics

RENDERING:

A rendering is a pictorial output of a 3D scene or object. Features like materials, lighting, oversampling and shadows control the effects and quality of the rendering. The more of these features you add, the more realistic your scene become, but also lengthens rendering times.

Materials and Textures:

You can control the way an object appears by applying color and textures. Materials provide realism with added effects. You an control glossiness (specular), self-emitting lighting characteristics, transparency and pattern repetition. Ray-traced can provide reflection (mirror) and refraction (transparency) effects. Textures can be made from any scanned photograph or drawn object in an image-editing or painting-type program. Images in almost any format (jpg, bitmap, png) can be used. Blender also has many built-in texture generators that can simulate a variety of surface characteristics such as wood, marble, clouds, waves and surface roughness.

Lighting:

Lighting provides the realism to your scene through reflections and shadows. You can control the type of light, intensity and color. Some lights can give a "fog" or "dusty" look with a halo or volume lighting effect. Illumination distances can also be set.

Cameras:

Your camera is your point-of-view for the scene. Just like a real camera, you can control lens length to achieve close-ups or wide angles. Clipping distance can also be set to control how far and near the camera sees. Depth-of-field can be controlled using nodes.

ANIMATION:

An animation is a series of rendered images that form a movie. The quality of your movie is controlled by all of the above mentioned features including frames per second (fps), output size, file type and compression. The most common method of animation is called *key-framing*. Key frames are created at various points in the animation while the computer generates all of the transition frames between the two keys. Basic animation options include changing size, rotation and location of objects.

Time Factors:

In order to animate, you must first set the length of your animation in frames and your frames per second (fps). The length in time can be calculated from these.

 Frame Rate Options:
 NTSC- U.S. and Japan video standard of 30 fps
 Film- Movie standard of 24 fps
 PAL- European video standard of 25 fps

*We typically use a frame rate of 25-30 fps depending on computer speed or if we plan to save the file to DVD. Hit the "PAL" or "NTSC" setting buttons for these.

Creating Keys:

A key is placed at the beginning and end of a desired move, size change or rotation of an object. Think in terms of how long you want a change to occur and relate it to your fps. For example, if you want an object to move from point A to point B in 2 seconds and you have 30 fps, place 2 keys 60 frames apart.

Following Paths and Objects:

In most animation programs, a camera can follow a path or object (or both) as it moves. This feature saves a lot of animation time and reduces the number of keys needed.

Output Options:

We typically save our movies in MPEG format for Windows. This type of file plays easily on most media players and at a high quality. Depending on how you plan to use your movie (i.e. on the web, saved to DVD, played in a presentation), you may wish to use different formats. Examples include Apple Quicktime and Windows AVI formats. Different formats also allow you to adjust the quality settings. For example, AVI formats can be compressed using a variety of compressors called CODECs.

Rendering sizes:

Animations are saved in a measurement unit called a _pixel_. Your computer and TV screens display images as small dots. The more dots, or pixels, per inch, the higher the resolution. Modern displays and TVs use square pixels, but older TV sets used rectangular pixels. This made it somewhat more difficult to render images because the output from 3D animation programs needed to be compressed into a non-square ratio format. Since most TVs have been replaced by modern flat screens, we can begin to get away from these older, confusing ratios and work with 1:1 pixel ratios.

Rendering and Animation

The next considerations deal with render sizes:

1. The older TV standard of 4:3 ratio size or the newer TV (and film)16:9 ratio size.
2. *Standard Definition* (SD) or *High Definition* (HD).

This decision will most likely be controlled by the type of result you need and how much time you have to render the project. Until recently, we have always worked with DVD standard definition 4:3 renderings in the classroom. We are changing most of our projects to HDTV 720p to better fit modern TVs and online video postings. While high definition renderings can produce better projects, the cost in rendering times would make it almost impossible for us to complete projects in the classroom during the school day, even with the small render farm we have in the lab. Standard definition still looks great played back on modern TVs and renders at a fraction of the time of higher HD. Here are the frame sizes for each type of render:

NTSC SD 720 x 480
PAL SD 720 x 576
HDTV 720p 1280 x 720
HDTV 1080i/p 1920 x 1080
Digital Cinema 2K 2048 x 1080
Digital Cinema 4K 4096 x 2160
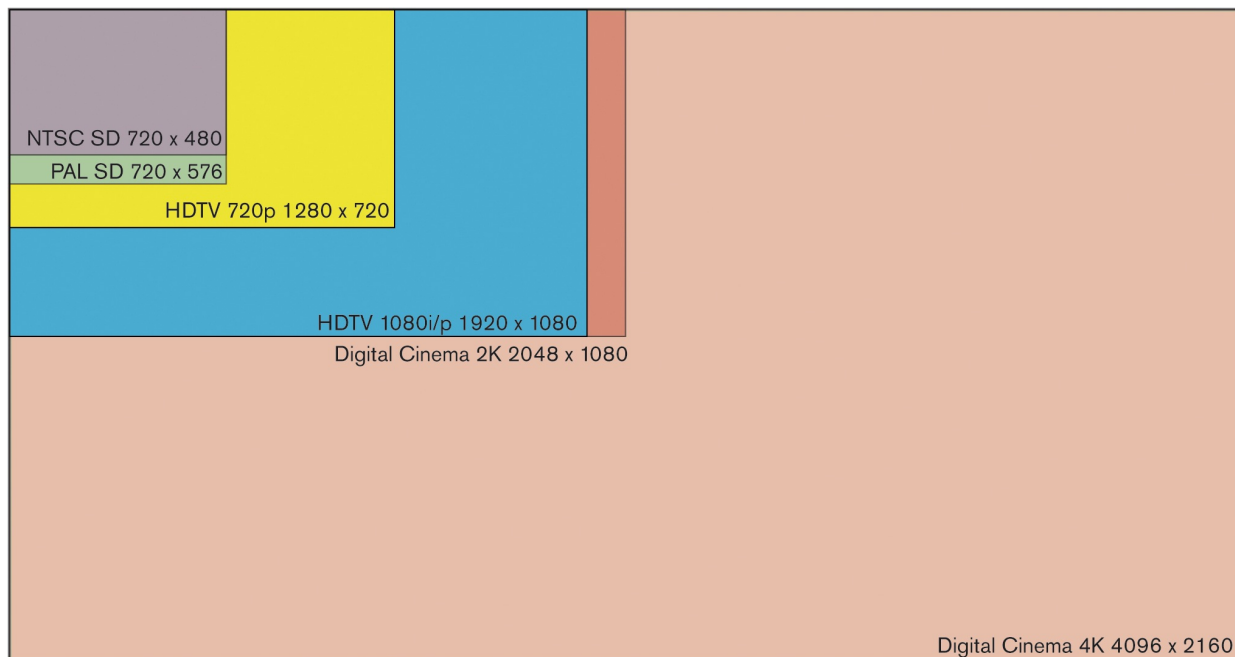
Real-Time Animation and Physics:

Blender uses the Bullet physics engine to make objects react in your scene like they would in real life. The Bullet physics engine was used in movies like 2012 to create all of the realistic-looking animations of falling and reacting objects. Real-time animation allows you to add physical properties to your objects and use the keyboard and other features to control them. You can create actors, change masses, control dampening (friction), set force and torque in x, y, and z planes and create relationships with other objects within the scene. With time and practice, interesting 3D games, animations, and real-time architectural walk-throughs can be created.

Blender allows you to use the physics engine to create animation tracks. You can now use the physics to create realistic falling, rolling, etc. animations and use them in movies.

Basic Blender Commands

This is just a partial list of Blender commands. Please visit the Blender.org website for more details.

TAB key- Toggles between **edit mode (vertex editing) and object select mode**. If you're in edit mode when you create a new object, it will be joined to the selected object.

Ctrl "Z"- The **global UNDO command**. With each press, one step will be undone (up to 32 steps possible by default). If in *edit* mode, it will only undo editing steps on the selected object.

Space Bar- Brings up a search window to find basic commands.

"Z" key- Toggles view from **wireframe to solid**.

Alt "Z"- Toggles a **texture/shaded view**.

"R" key- **Rotates** an object or selected vertices. (pressing X,Y,Z after "R" will limit effect)

"S" key- **Scales** a selected object or vertices. (pressing X,Y,Z after "S" will limit effect)

"G" key- **Grabs or moves** the object or selected vertices. (pressing X,Y,Z after "G" limits effect)

"A" key- While in edit mode it's good for **selecting all vertices** for commands like remove doubles and subdivide. Pressing "A" twice will clear selected and reselect.

Alt "A"- **Plays animation** in selected window. Your cursor must be in that window for it to play.

Ctrl "A"- After an object has been re-sized and/or rotated, this can **reset the object's data** to 1 and 0.

"W" key- Brings up a "**Specials**" menu while in edit mode of **specific edit mode options**.

Shift-"D"- **Duplicates or copies** selected objects or selected vertices.

"E" key- While in edit mode, selected vertices can be **extruded** by pressing "E".

"O" key- The "O" key (not zero) will put you into **proportional vertex editing** while in edit mode. Proportional editing now also works in object mode.

"B" key- Gives you a **box (window drag) to select multiple objects**. In edit mode, works the same to select multiple vertices.

"C" key- Gives you a **circle select** in edit mode that can be sized by scrolling the mouse wheel. Press LMB to select, press wheel to deselect. Right mouse click or "Esc" to exit.

Shift-"A"- Brings up the **tools menu** where you can add meshes, cameras, lights, etc.

Number Pad- **Controls your views**. "7" top, "1" front, "3" side, "0" camera, "5" perspective, "." zooms on selected object, "+ and –" zoom in and out. The + - buttons also control affected vertices size in proportional vertex editing.

Mouse- Left to manipulate (**LMB**), right to select (**RMB**), center wheel to zoom and rotate view. If you hold down "shift" and center wheel you can pan around on the screen.

Shift Key- Hold down the shift key to **make multiple selections** with the right mouse button.

Arrow Keys- Used to **advance frames in animation**. Left/right goes 1 frame at a time, up/down goes 10 frames at a time.

"P" key- While in *edit* mode, pressing P will **seperate selected verticies**. In *object* mode, pressing P will cause you to enter into the **game (real-time) mode**. Press *Esc* to exit game mode.

ATL/CTRL "P"-Creates or breaks **child/parent relationships**. To create C/P relationships, hold down shift key and select *child* first, then *parent*. Hit Ctrl P. To clear a relationship, do the same except hit Alt P.

"U" key- In Object Mode, brings up the **Single-User menu to unlink materials, animations (IPOs)**, etc. for linked or copied objects.

"M" key- **Moves selected objects to other layers.**

Ctrl "M"- **Mirrors** an object. Select "M", then X,Y,or Z to mirror on that axis.

"N" key- Brings up the **numeric info. on a selected object** (location, rotation and size). Info. can then be changed in the panel.

Practice Exercises

Ctrl "J"- **Joins selected objects** together.

Ctrl "L"- **Link mesh's data to another mesh**. Good for copying materials and other object data from one object to other objects. While holding the Shift key, select all the objects with the one containing the material or other data last. Press Ctrl-"L" and select you option.

"F" key- **Makes a face in edit mode** of the selected vertices. You can only select 3-4 vertices at a time to make a face. By selecting 2 verticies and pressing F will close shape.

Alt "F"- **Will Face or Fill** a closed set of selected verticies.

Ctrl "F"- Brings up a **"Face Specials" menu** with other face options.

Shift "F"- **Camera Flying** is enabled and will cause the camera to "fly" through the scene.

"X" or Delete- **Delete** selected objects, vertices or faces.

"K"-LMB In *edit* mode, K and left mouse button will allow you to **slice faces**.

Ctrl "R"- In *edit* mode, will bring up options to **slice or cut faces**.

Shift- "S" In both *edit* and *object* modes, this will give you options to **locate objects or the cursor** to assist in precise placement.

Function Keys-F1-Load File; F2-Save File; F3-Repeat History; F11-Last Render; F12-Render

"I" Key- The "I" key is used to **insert animation keys** for various things. Objects can be animated with basic Rotation, Location and Size keys and combinations there of.

"T" Key Opens the **Toolbox** at the side of your viewport.

Ctrl "T"- Used to create a **Track To Constraint** to make one object follow another (like a camera with a target).

Ctrl "S"- Used to **Save** your Blender file

Alt "C"- Used to **convert meshes, text and curves.** For example, text can be converted into a mesh for other transform options.

"Shift" "Space" Toggles between **multiple screens to full screen** of active view port. Can also use **"Ctrl"-"Up Arrow"** to do the same thing.

Ctrl "0"- If using multiple cameras, this will **switch to the selected camera**. (Number pad "0")

Armatures- Meshes can be controlled by "bones" or armatures. Create a mesh with vertices at the joint locations, then create an armature string within it. Child/Parent the mesh to the armature using the armature option. You can then animate in Pose Mode.

Ctrl-Tab- Puts you into **Pose mode** for manipulating armatures.

Import/Export-Blender accepts many different file formats through the import/export commands. When inserting other Blender files or objects into another scene, use the APPEND option from the file menu and select the appropriate options. Multiple objects can be selected with Shift-Right mouse button.

Multiple Viewports- To create multiple viewports, move your cursor to the upper-right corner of an existing viewport. When your cursor turns into a "+" over the tab triangle, press LMB and drag to spit viewport area. To join areas, repeat the process.

The Basic Blender Buttons:
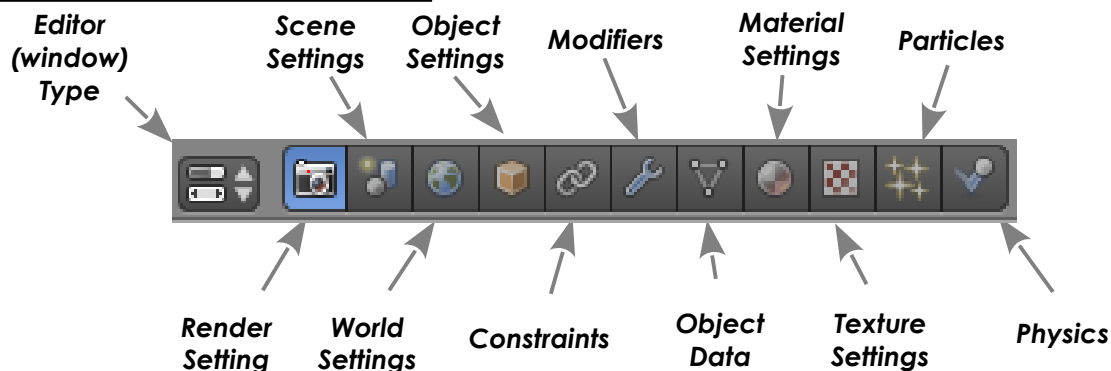
The Blender Screen

Years ago, when I first looked at Blender and read some tutorials I thought that this looked easy and made sense. After taking the program for a test run, I decided to forget about it for a while because I couldn't make anything. The interface is different than any other programs I've experienced before. I thought I'd try again and after a few weeks however, things began to make sense and I realized the potential of the program. If you tried Blender before the interface improvements in version 2.5, you may enjoy the program better this time. Here's what you see when you open the program:
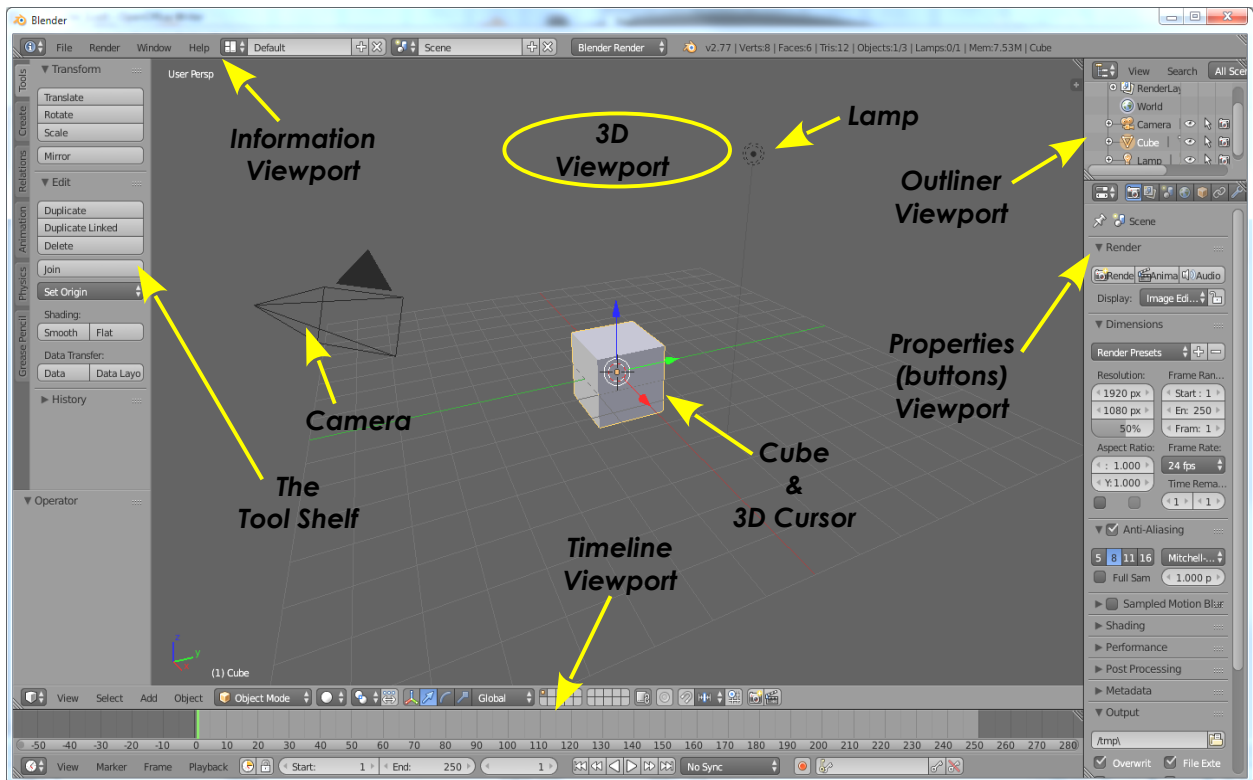
You are looking at a scene consisting of a cube, lamp and a camera. The cube is a basic mesh object to give you something to look at, a lamp to illuminate the scene, and a camera to show the scene. Older versions of Blender may open with different scenes, but the idea stays the same. The 3D cursor in the middle of the cube is used to locate where new items will be placed. It can be moved around on the screen by clicking the Left Mouse Button (LMB). Along with familiar pull-down menus like other programs, you have multiple viewports (windows) on the screen serving different purposes. We will talk about these later and how they can be changed.
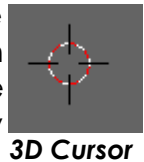
3D Cursor

Blender works with layers much like other programs where objects can be placed in different layers and displayed as needed. It's a good idea to get comfortable with layers because as your scenes get bigger, turning layers on and off help with the speed of

your work and being able to see things better. To change things between layers, select the object with the **Right Mouse Button (RMB) and type "M" for move**. Try it with the cube and change layers. If you put it in a layer that's turned off, <u>it will disappear</u>. To turn that layer visible, click **(LMB)** on that button. To turn on multiple layers, hold down "<u>Shift</u>" and click on the buttons. Layers containing objects will display a dot.

> <u>***RoboDude Asks:***</u>
> ***"How do I select multiple objects in Blender?"***
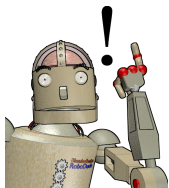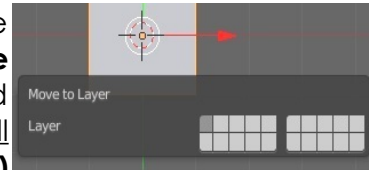> *Hold down the "shift" key while using the RMB (Right Mouse Button).*

Viewport (Window) Types

Blender has a variety of different viewport, or window, types and every viewport can be set to any type. For example, your initial screen has 5 viewports (see previous page), the top one with the tool bars (Information viewport), the 3D viewport, and the bottom Timeline window. On the right, you have the Outliner and Properties viewport. The button to change viewport types is in the upper or lower left corner of each window. There are a lot of viewport types. The ones we are most interested in are:
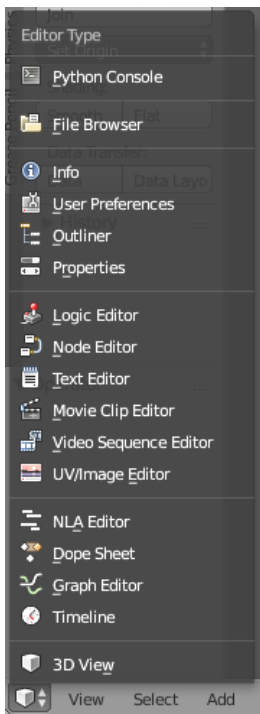
<u>File Browser</u>- usually comes up automatically as needed
<u>Info</u>- menus, screen, scene and render engine options
<u>User Preferences</u>- can be selected from the "File" menu
<u>Outliner</u>- displays all objects in your scene and settings
<u>Properties</u>- once called the buttons window, where most
  settings and scene options occur
<u>Logic Editor</u>- game and real-time animation controls
<u>Node Editor</u>- post-production effects for a scene
<u>Video Sequence Editor</u>- compile final movies with images,
  effects and sounds
<u>UV/Image Editor</u>- setting textures for games and movies
<u>Graph Editor</u>- replaces IPO window- displays animation data
<u>Timeline</u>- animation timeline with display and record controls
<u>3D View</u>- your basic 3D scene window where you work

Ready-Made Screens

Blender has several ready-made screens for you to choose from that make optimal use of these windows. They can be accessed from the top pull-down menu area. Besides "*Default*", you can choose depending on what you're doing.

The User Preferences Window

The User Preferences Window can be called up by selecting it in the "File" pull-down menu. This is where you can customize Blender to react to your particular needs. If you would like these setting to be in place every time you open Blender, you can save them by clicking the "*Save As Default*" button or by pressing **Ctrl "U"**.
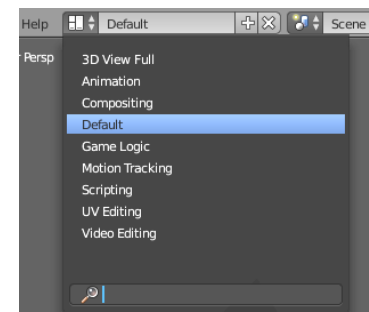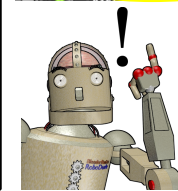

RoboDude Says:

Be careful to only use this setting at the beginning of a drawing session and on your own personal machine (not school computers, unless the instructor approves). If a drawing is open at the time, that drawing will automatically open every time you use Blender. It will become the default scene and replace the cube, lamp and camera basic setup!
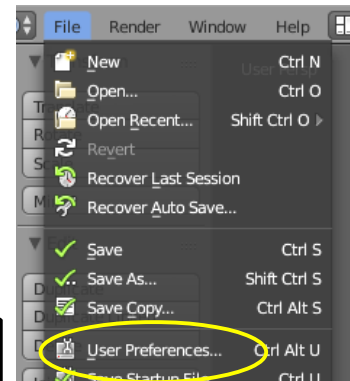
Blender works well using the default settings, but there are several things you may want to change for your own use to stream line your work flow or react better for your computer. By looking at the tabs across the top of the window, you can select options in several areas. Here are a few you might want to look at:
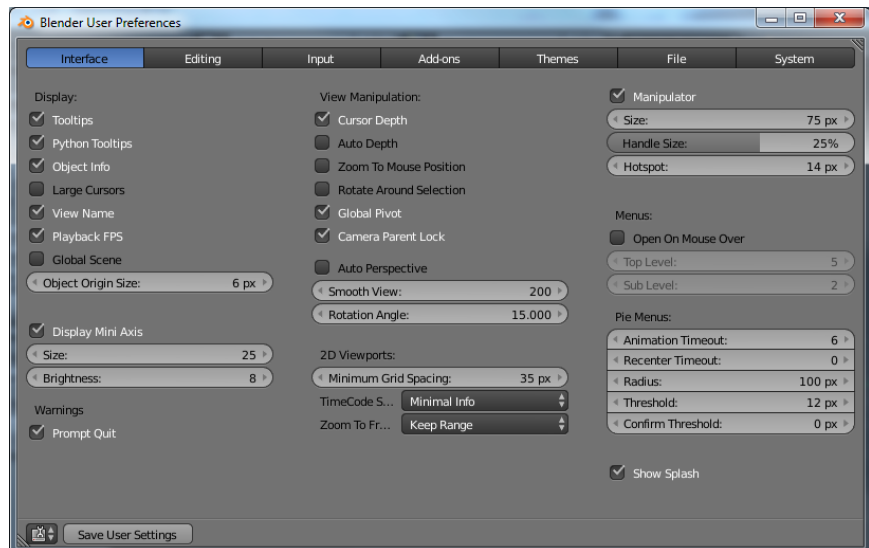
Editing Tab- Instead of new objects aligning to the "World", you may want to try "View". The Global "Undo" steps are defaulted for 32. If this isn't enough, add more.

Input Tab- The "Emulate Number Pad" option is great for laptops without number pads.

Add-Ons Tab- There are some great add-ons included. A good one is "*3D View: Dynamic Context Menu*". Provides an "add object" menu with the space bar.

Themes Tab- This is where you can change the appearance of everything!

File Tab- If you save sounds, textures, etc. in specific folders, set the paths to save time.

System Tab- If you need to make adjustments to sound and memory or game setting, they can be done here.

Some of these settings will be examined more in the "*Setting Up Your Interface*" task.

Open, Saving and Appending Files
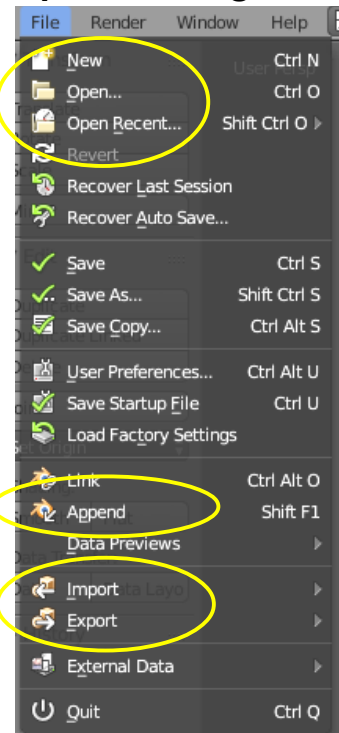
Blender utilizes commands similar to other programs when it comes to saving and opening your work with a few exceptions. Blender can use the "**Open**" command to open Blender (.blend) files and the "**Append**" command to bring in elements from other Blender files into another Blender file. Blender also has extensive **Import** and **Export** options in the file menu that work well with VRML (.wrl),.DXF, and .STL files. These are generic file interchange extensions that most programs can work with, as well as 3D printers.
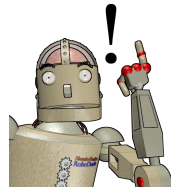
> ### *RoboDude Says:*
> *Be careful to save your work often! Like most programs, Blender will give you a basic warning to save your work when exiting the program, but that is all- it will just close, losing any work you may not have saved.*

The Save Command:

When you first start working with Blender, it seems almost impossible to figure out how to save your work. The file interface almost resembles old MS-DOS. Also, every time you save over an existing file, your previous save becomes a back-up file and is saved with a new extension (.blend1). This always gives you a back-up if a problem occurs. Here's what you see when you hit the save command:

Folder Navigation and Viewing   *View Filters*   *Save Button*
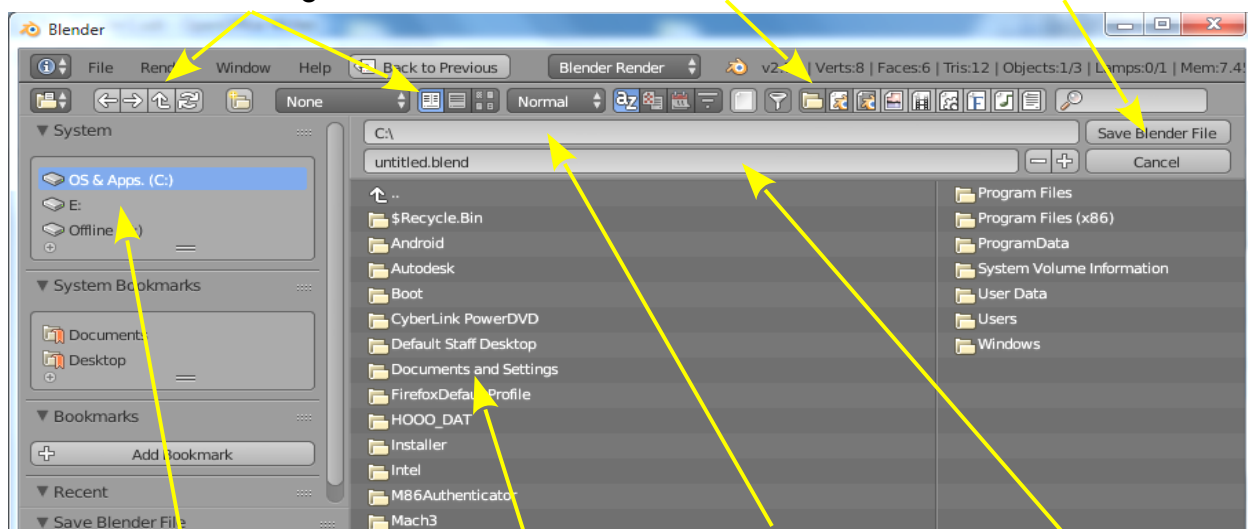
Available Drives and Bookmarks   *Sub Folders and Files*   *Path where work will be saved*   *Where you name your file*

The Append Command:
When you need to insert elements from one Blender (.blend) file into another one, you need to use the **Append** command from the file pull-down menu. While in Append, you need to navigate to the Blender file you wish to insert from, then select what you want to append into the open file. You can append anything from cameras, lights meshes, materials, textures, scenes and objects. For most purposes, use the **Object** option. By appending objects, any materials, textures and animations that are linked to that object will automatically come in with it. Left Mouse Button (LMB) clicking on objects will select\deselect them (hold down "Shift" to select multiple objects). Typing "A" will select them all. After you select all objects to append, click the "Append from Library" button in the upper right corner of the screen.

The **Link** option allows you to link to another Blender file rather than inserting it into the open file and also found in the File menu. This option allows for changes to the linked file that will be automatically updated when the other file is opened.

Packing Data

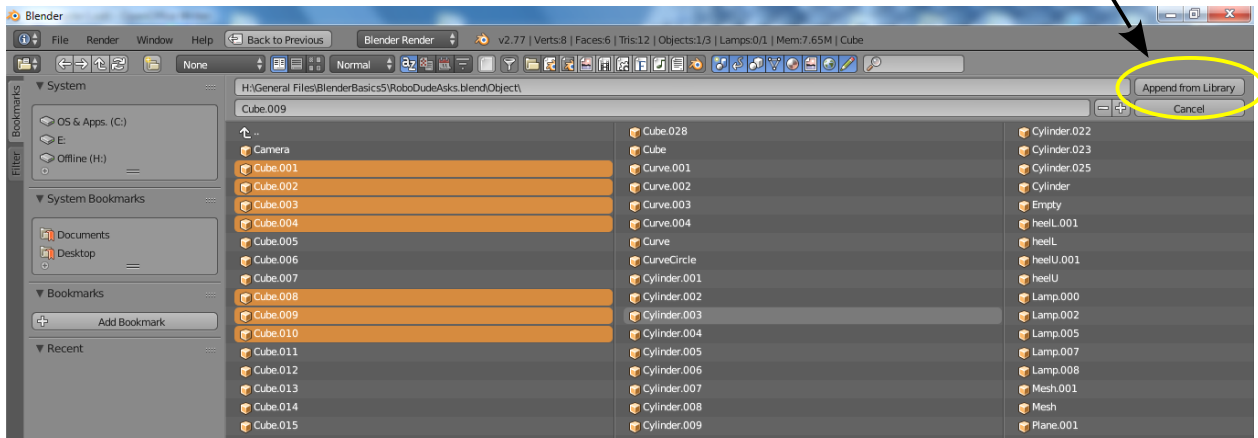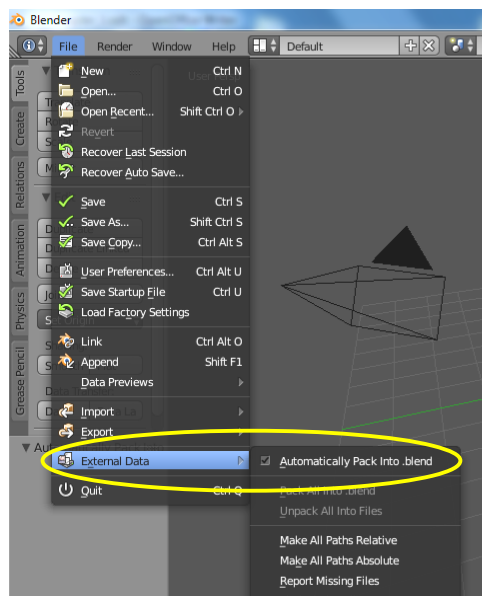If you plan to open this file on other computers, you will need to select the "**Automatically Pack into .blend file**" option in the File menu under **"External Data"**. Textures and sounds are not automatically included in your Blender file in order to keep the file size down. Every time your file opens, it looks for the textures and sounds and places them into your model. If it can't find the files, you won't have any textures and sounds. If you pack data, those files are included with the .blend file so they can be opened anywhere, however, your file size may explode. You can also unpack data to bring the file size back down.

Importing Objects (from other file formats)

One of Blender's strong points is the program's ability to accept several generic types of 3D files from other programs. The most popular used are:

.STL files-   STL files have grown in popularity in recent years, being fueled by the 3D printer movement. Just about every 3D printing slicing program will accept .stl files. A unit on processing 3D printer files appears toward the end of this book.

.DXF files-   A very popular file format for exporting and sharing. AutoCAD and SoftPlan architectural software traditionally exports with .dxf formats.

VRML (.wrl) files-   Once a popular 3D file type, .wrl files seem to be losing ground to .stl files.

To save a file as one of these types from another program, you will need to find an *export* command or a "*save as*" option. This will vary depending on the program you are using. Refer to that program's help files. To import a STL, VRML or DXF file into a Blender scene, open a new drawing or one you wish to insert the object(s) into. You will simply need to use the *Import* command in the *File* pull-down menu. Now you need to find the object(s) you just inserted. Depending on how that object was drawn, it may need to be re-sized or rotated.

With every new release of Blender, the import/export format options list grows. You should be able to find a format in the list that will work with your other programs.

If a file format isn't available, check in the "Add-Ons" section in the User Preferences menu under "File". There may be an add-on script written for your file type, but not turned on.
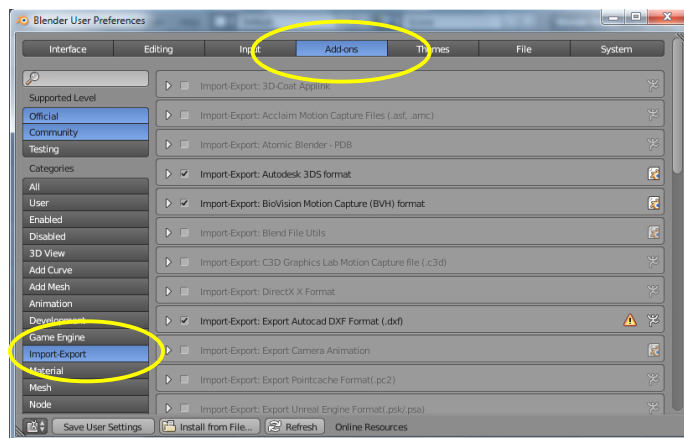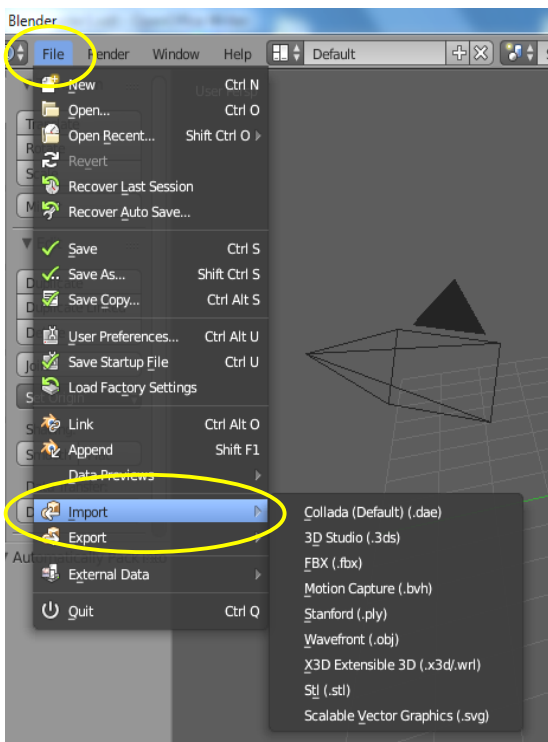
Scenario:
You work for an advertising firm where you work with specific files and use certain tools all the time. It would be nice to be able to set Blender so it opens with these setting turned on by default every time.

Customizing You Screen Settings:
In order to get some practice adjusting interface settings, set up your Blender program to some of these commonly used, but not initially enabled features in the User Preferences settings:

- **Input Tab:**
  -Check "Emulate 3-Button Mouse" if you do not have a mouse with a wheel. The Alt-Left button will act like a mouse wheel.
  - Check "Emulate Numpad" if you are using a keyboard without a number pad. This will make the buttons 1-9,0 act like the number pad buttons, useful in the next chapter.
- **Add-Ons tab (*enable the following*):**
  - 3D View: Dynamic Context Menu (easily add object by using the spacebar).
  - All of the "Add Curve" and "Add Mesh" options.
  - Any additional Import-Export commands you need or instructor recommends.
  - Look through the list for any other add-ons of importance to you.
- **Themes tab:**
  - Experiment with the preset themes to see if any interest you.
  - There is a "Reset to Default Theme" to go back to the basic theme.
- **File tab:**
  - If you have textures, sounds, or fonts saved in a specific location and would like Blender to go there directly every time you want to add one of these resources, set these paths now by clicking on the file folder picture by each line.
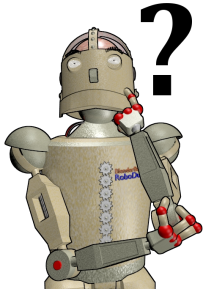 - If using a standard Windows computer, set the path to the following for fonts:

If you are using a personal computer or your instructor tells you to do so, press the "Save User Settings" button on the lower-left corner of the User Preferences window. Every time you now launch Blender, these setting should now be the defaults.

Call the instructor when finished

Chapter 1 Reflection and Wrap-up:

Program Interfaces and User Reactions

A computer program's interface can make or break the program's success. If the interface is difficult to navigate, it can frustrate users and drive them to find an alternate program. While other 3D modeling and animation programs may use catchy graphic icons and ribbon menus for operations, Blender tends to stick to basic text buttons and menus.

1. In terms of learning a new program, which type of layout do you feel may be easier to use? Explain your answer.

2. In terms of being quick and easy to use for the seasoned professional, which type of layout do you feel may be easier to use? Explain your answer.

3. Examine at least one other 3D animation program online (Maya, Lightwave, 3D Studio, etc.). By looking at website screenshots and descriptions, how does Blender compare with their interface? Name at least 3 things that appear similar and 3 things that appear different.

4. Compare Blender's features to the same program you selected in #3 by looking at feature lists on each program's website. How do they compare in features and price? Explain your answer.

Moving Around in 3D Space

In a 3D program, not only do you have to worry about where you are in 2 dimensions (height and width), but you also need to consider depth (how close or far away). Before you can work in 3D space, you should have some skills in 2D drawing and layout. **Moving around in the 3D window is controlled by the mouse and the keyboard number pad (<u>NOT</u> the numbers across the top of the keyboard- these change layers)**. Think of a standard 3-view orthographic drawing- top, front and right side views. These views match up with the number pad **7,1 and 3 keys** (look at their arrangement on the keyboard- just like the views). Put your cursor in the 3D window and try typing those numbers. Typing "0" will put you into camera view (what the camera sees).
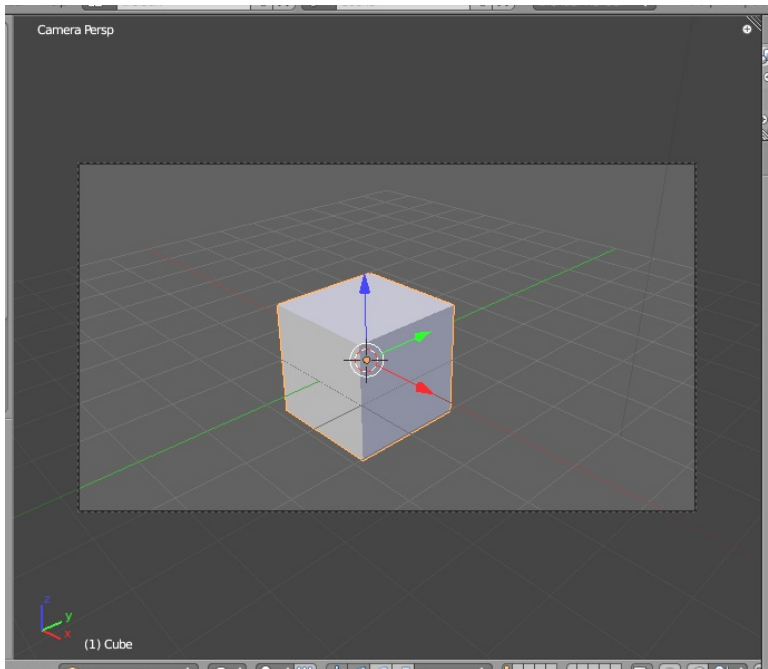
By default, the camera is represented by a single line, representing the edge of what is rendered and shaded to the outside. You also have the option of turning on an additional dashed line box to represent a *Title Safe* box (helpful in planning). Changing these settings will be discussed in a later chapter. You will also notice a small note in the upper-left corner of the viewport telling you the view name and if it orthographic or perspective.

The number pad 5 key will always toggle you between perspective and orthographic views. The number pad arrow keys (2,4,6,8) will rotate you around in 3D space. The "+" and "-" keys on the number pad will zoom in and out. The number pad "." (period) key will center your view up on the selected object on your screen. <u>***"Ctrl" and 7,1, or 3 will give the opposite view.***</u>

The mouse serves a number of functions. The Left Mouse Button (LMB) will move the 3D cursor around on the screen and for dragging windows for selecting objects. *Wherever the 3D cursor is located is where the next item you create will be placed*. The 3D cursor serves other purposes that we will discuss later. The Right Mouse Button (RMB) is used to select object or vertices (in edit mode). The mouse wheel serves 2 purposes. <u>*Scrolling*</u> the wheel zooms in and out (like the + and - keys). <u>*Holding down the mouse wheel*</u> will let you rotate the view. <u>Holding down *Shift and Mouse Wheel*</u> will let you pan around on the screen.
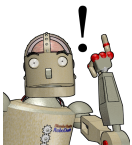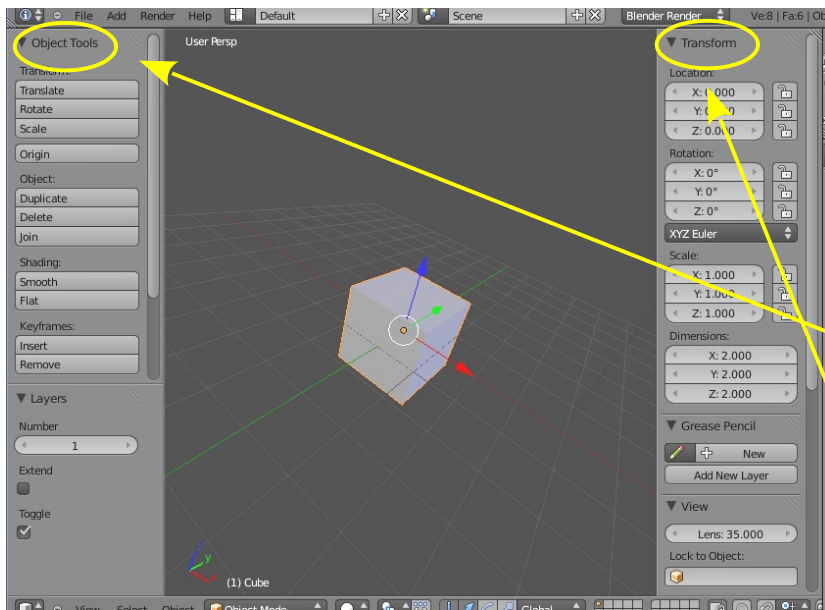
RoboDude Says:
Practice using these controls before moving on to other lessons. Without getting a grasp on working in 3D space, you will have a difficult time creating and modifying objects.

Chapter 2- Working with Viewports

Window and Button Control

So now you know how to save your Blender file and move around in 3D space. We're still not really able to create anything yet, but soon. You have a default screen with several viewports. You may have noticed that along with the *Tool Shelf* on the left side, you can also have a *Transform* panel on the right of your viewport. These are definitely useful panels as you will soon see, but they take up a lot of space. You can minimize them by dragging on the edge of them with the LMB while your cursor looks like a left/right arrow. So how do you bring them back out when you need them? With your cursor in the 3D window, you could type **"T"** for the *Tool Shelf* or **"N"** for the *Numeric Transform* panel. This will open the panels up again (pressing either button a 2nd time will close the panel up). You can also click on the small **"+"** symbols at the sides of the viewport to open them.
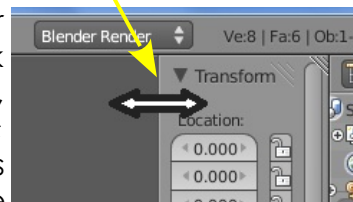
The 3D View Window Header:
A lot of the key commands we will talk about in the book can be controlled in the Window Header. Some of the common operations found there are:

Drawing Modes | **Display Shading** | **Pivot Points** | **Manipulator Widgets** | **Layers** | **Proportional Editing** | **Snapping** | **Rendering**

Scrolling in the Properties Panel:

You may notice that many of the buttons and panels are off the screen. Accessing those buttons can be done by holding down your mouse wheel (like it's a button)and using it to pan left-to-right. The same can be done to access the panels below the buttons. You can also use the "+" and "-" keys on the number pad to zoom in and out on the panels.

Panels can also be minimized and maximized to take up less space by clicking on the small triangles found on each.

2-2

Creating Viewports (also called windows)

Most times, you need more than one 3D window to work with since you're trying to locate objects in three dimensions. Most rendering and animations programs allow for multiple viewports along with graphical views of various data. Blender allows the same. Remember that Blender starts with 5 viewports, but only one 3D View window (discussed on pages 1-1 and 1-2). You can change the size of any of these windows by using the LMB and dragging on the line between the viewports. In order to split a viewport, move your cursor over the *small triangle in the upper right* corner of the 3D View Window. When the cursor turns into a "**+**", drag with your LMB to split your screen into 2 viewports. Joining viewports together works the same way. Click on the triangle and drag over the viewport you wish to remove. There's no limit to the number of times you can split your windows. I like to traditionally work with 2 views like the example shown below. I use the left view to flip between my principle views (top, front, side) and the right view for camera view and animation tracks (which we'll discuss later). In the view shown below, I've minimized the Tool Shelf and Transform Panel to maximize screen space.
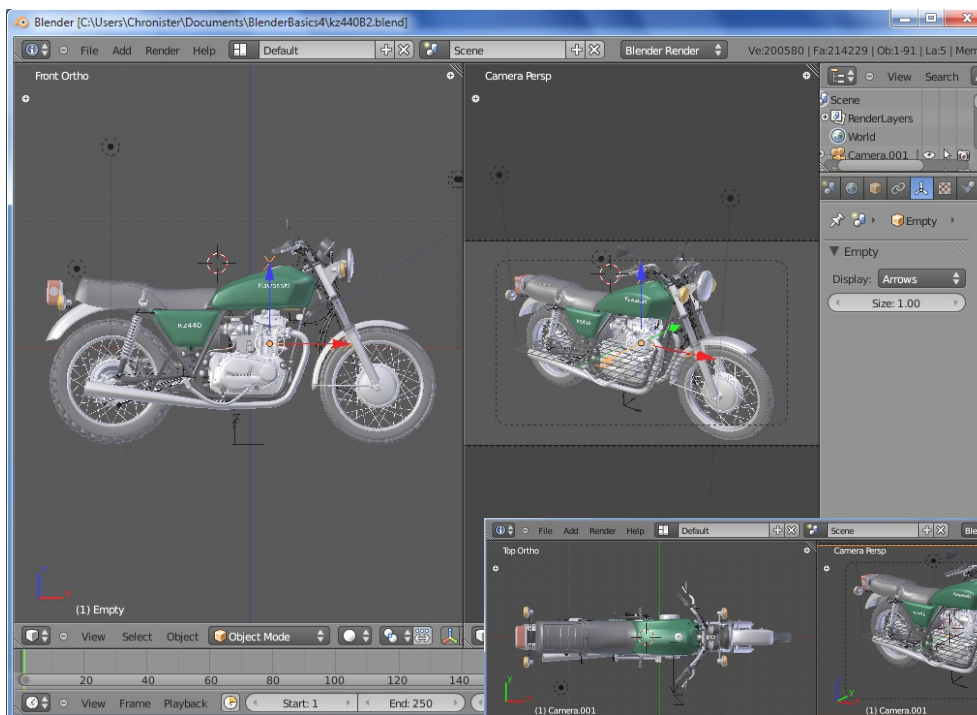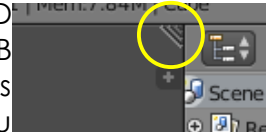
Windows can also be split along a vertical line. Some 3D programs traditionally give you 4 viewports that are set-up as front, top, right side, and perspective or camera views. Basically, it is up to what you want to work with.
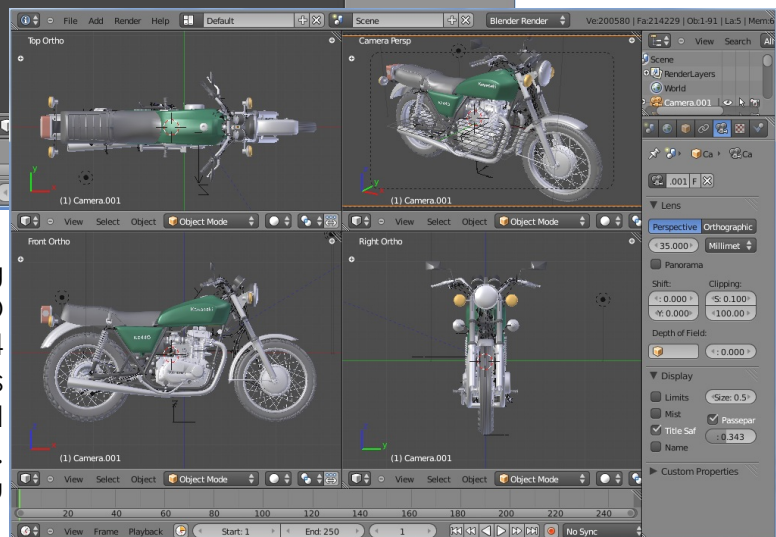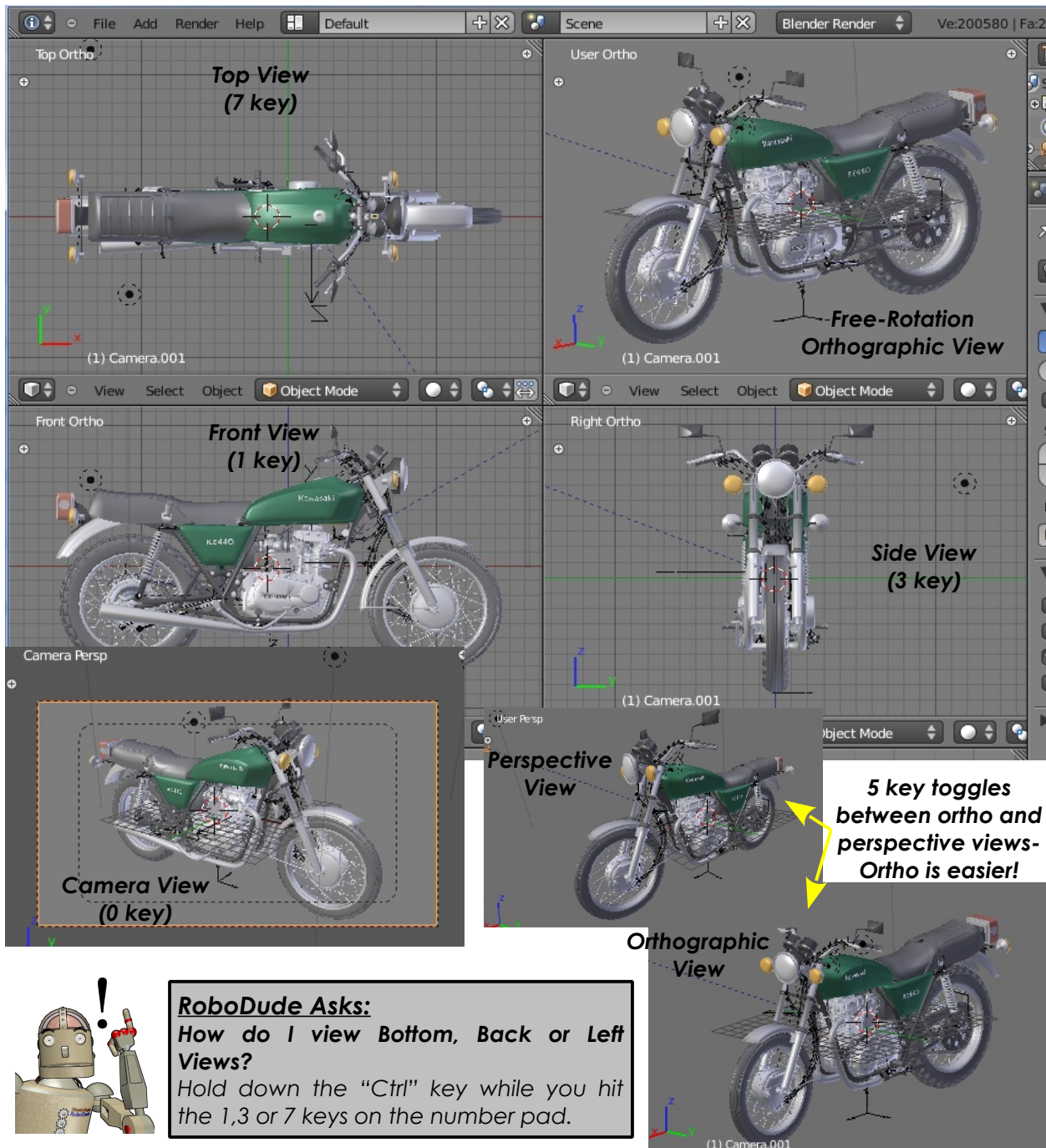
Chapter 2- Working with Viewports

Typical Views and Buttons:

Here are some typical views used to model in 3D and the buttons on the **number pad** to go along with them. In order to make them work, you need to have the "*Num Lock*" button pressed. Get use to working with the principle views (top, front, side) in *orthographic mode* when locating the 3D cursor. You will usually need to check the location of the cursor in at least 2 views when placing objects. New to Blender 2.6 is that the name of the view is displayed in the upper left corner of the viewport.


Top View (7 key)

Free-Rotation Orthographic View

Front View (1 key)

Side View (3 key)

Camera View (0 key)

Perspective View

5 key toggles between ortho and perspective views- Ortho is easier!

Orthographic View

RoboDude Asks:
How do I view Bottom, Back or Left Views?
Hold down the "Ctrl" key while you hit the 1,3 or 7 keys on the number pad.

In order to get some experience with these commands, set up a screen with four viewports using a top, front, side and camera or perspective views as displayed below:
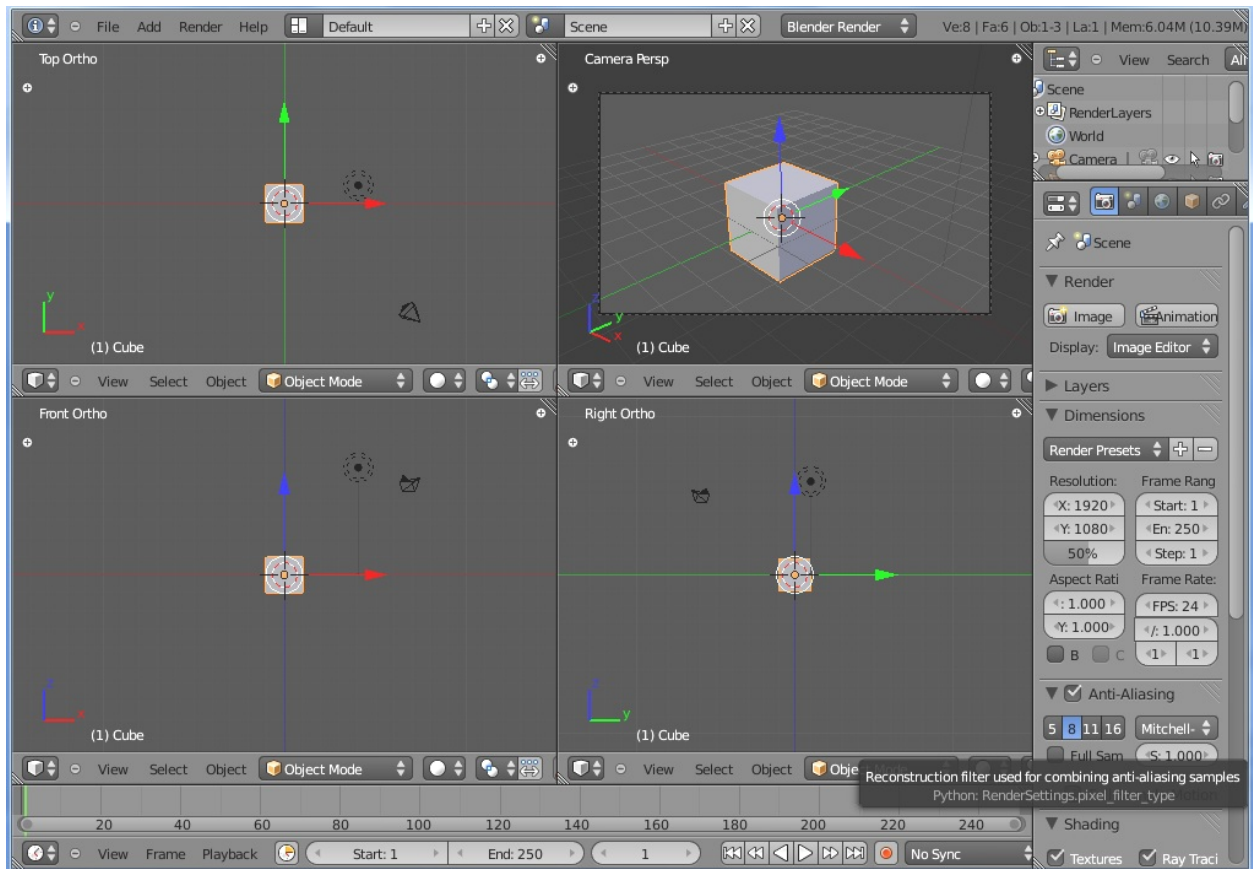
Be prepared to be able to demonstrate the following techniques to the instructor when asked:
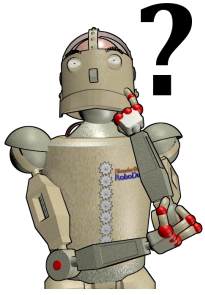
- *Panning around on the screen, scrolling the buttons/panels*
- *Zooming*
- *Changing window types*
- *Centering the view on a certain object*
- *Switching views (top, front, side, camera, free-rotate)*
- *Opening and closing the Tool Shelf and Transform Panel*
- *Closing (collapsing) a viewport*

** Call the instructor when finished**

PERFORMANCE TASKS
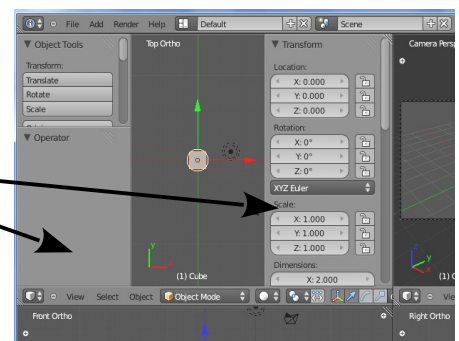
Chapter 2 Reflection and Wrap-up:

Working in a 3D World

While we live in a three-dimensional world, it is an entirely different thing to work in a computer generated three-dimensional world. 3D work spaces can be difficult for many students to grasp. Practice is the key.

1. Blender uses the number pad and mouse to control your 3D views and location. If you were asked to re-design the commands for moving in 3D space, would you use the same configuration, or develop something different? Explain your answer.

2. How does working in 3D space relate to math? Where have you ever used the concepts of X,Y, and Z in a math course? Explain your answer.

3. Research GPS on the internet. How does GPS work so that it can determine where you are on a map?

Working with Basic Meshes

Now that you can move around in Blender, let's start doing some basic building and shaping. In this chapter we will talk about creating basic shapes and using modifiers to form them. Blender has a lot of different object types. Right now we will only discuss *Meshes*.

Start a new drawing in Blender and save it in your "My Documents" directory, or other specified drive. Call it *Sculpture*. *Since there a variety of operating system and saving structures, you may need to set up folders as needed.*
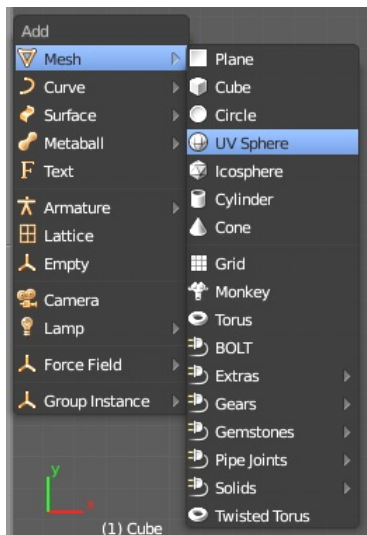
RoboDude Asks:
Why do I keep losing my work?
Since Blender's file interface differs from most other programs, it can be easy to lose track of where you are saving files and not saving often enough.
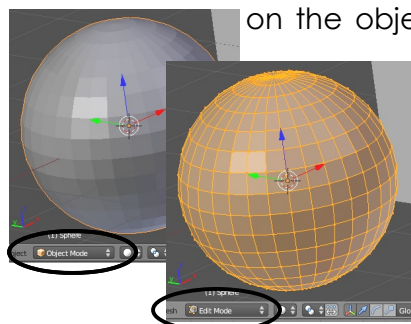*Remember to always save your work often!*
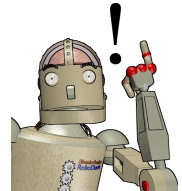
Placing Objects On Your Screen:

The 3D Cursor (bulls-eye) location is used to place new objects. Use the left mouse button to move the cursor in 3D space When you have it in a good location, press **Shift-"A"** to bring up the insert menu (*or space bar if you enabled the dynamic space bar add-on*). Select **Add**, then **Mesh** and select **UV Sphere** *(my mesh menu may display more items than your menu due to selecting different add-ons in the preferences menu).* You will then be asked how many segments and rings you want in the bottom of the **Tool Shelf** (*open this if closed with the "T" key)*. You can change these by dragging the mouse in the block or by clicking in the box to type. Your sphere will change to reflect your settings. You can also adjust some other settings there.
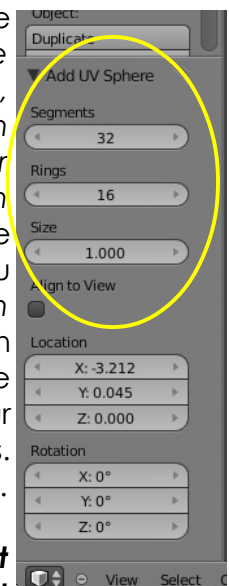
When you place an object in Blender, it comes into the scene in *Object Mode*. There are basically 2 states in Blender- *Edit Mode* and *Object Mode*. Edit mode is intended for modifying the shape of the object by selecting vertices on the object. Object mode affects the object as a whole. The *Tab* button toggles you between the two. You can also see and change your mode at the bottom of the viewport. *After inserting an object into your scene, always make sure you're in Object Mode. Otherwise, the next object you create will be joined to that mesh!*
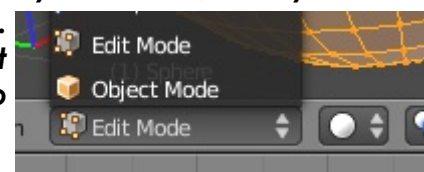
Chapter 3- Creating & Editing Objects

As mentioned on the previous page, another way to switch between **Edit** and **Object** mode besides using the **Tab** key is to use the **Mode menu** at the bottom of the 3D screen. Notice that there are a few more modes than just Edit and Object. Some of these will be discussed in later chapters.

Precise 3D Cursor Placement:

To precisely place the 3D cursor, use the "**Shift-S**" keys for options to move the cursor to objects, grid, and vice-versa.

Mesh Types

When pressing the space bar and choosing to add a mesh, you will notice several mesh types (often called primitives) available. More can be added through *Add-Ons* in the *User Preferences* menu. They are:

Plane- A simple two-dimensional shape. Can be sub divided and used with proportional vertex editing to make nice hilly terrain or shaped.

Cube- Basic 3D shape. Nice object to start with to shape into rectangles and other shapes.

Circle- Won't display as a 3D object unless filled, but can be extruded and shaped.

UV Sphere- A sphere generated with rings and segments, like the latitude and longitude of the earth.

Icosphere- A sphere generated with triangular shapes. Like Epcot Center.

Cylinder- Like a can, with ends closed, but if you leave the ends off, it is a tube.

Cone- Basic closed cone shape.

Grid- Can be used and extruded like the plane.

Monkey- A fun shape that someone decided to include in the mesh list.

Empty Mesh- A mesh without any visible vertices, edges or faces.

Torus- A donut shape.
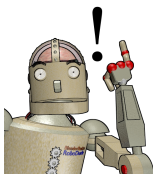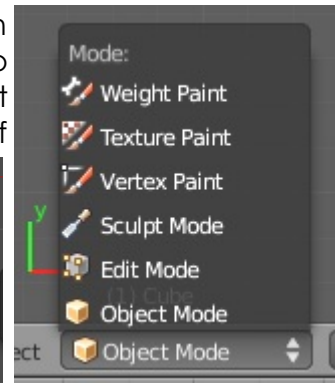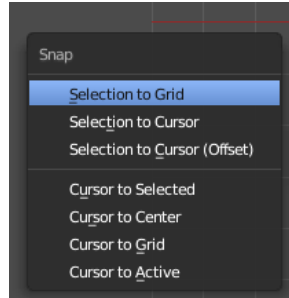
> **RoboDude Asks:**
> **How do I set the quality of a mesh?**
> *Remember that after selecting a mesh type, you will see the settings for that mesh at the bottom of the Tool Shelf. Also, don't forget to be in **Object Mode** when making a new mesh- otherwise, your new mesh will be joined to another mesh.*

## Using Main Modifiers to Manipulate Meshes

Before we look at actually changing the shape of the meshes and turning them into other shapes, we should become comfortable with creating, moving, rotating and scaling basic meshes. The three main modifying commands used in Blender are:

**"G" key- move or grab and object**
"S" key- sizing or scaling an object
"R" key- rotating an object

If you would like to do any of these operations through an exact number (i.e. rotate 90 degrees on the X axis or size something to a specific number), type the "**N**" key to bring up the *Transform* bar on the right side of your screen (or click the small "+" at the top right corner). You can also lock numbers.
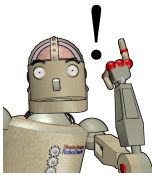
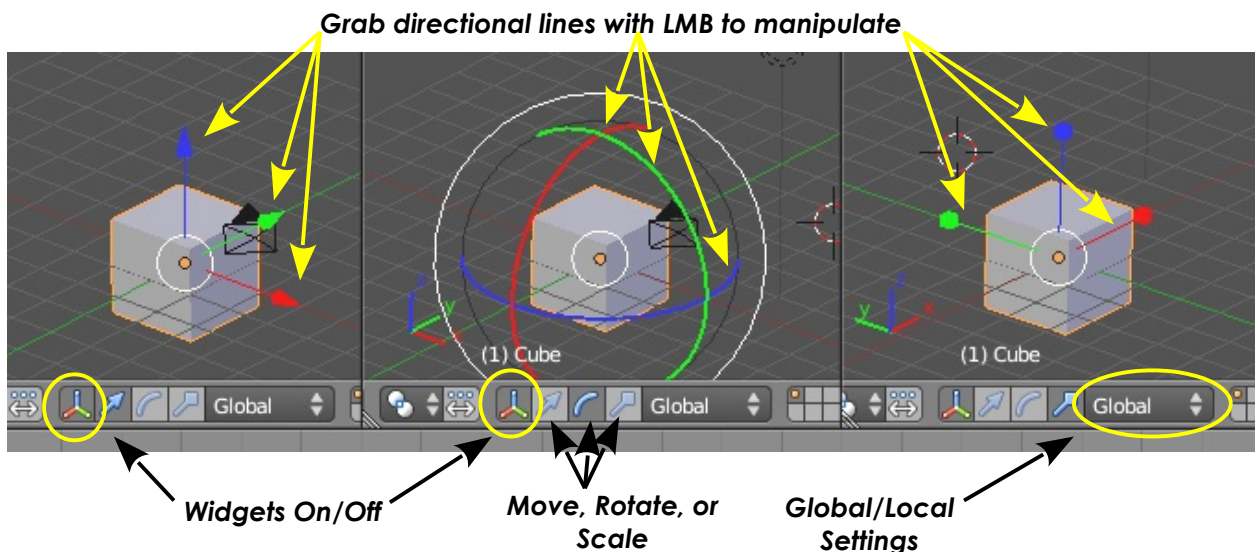*RoboDude Says: If you would like to move something along a straight axis line (X,Y,Z), enter the Move command and drag the object the direction you wish to go. Press the mouse wheel (don't scroll, press it like a button). The object will lock on a straight line. In the Move command, you can also type X,Y, or Z. In the rotate command, type a number after typing "R".*
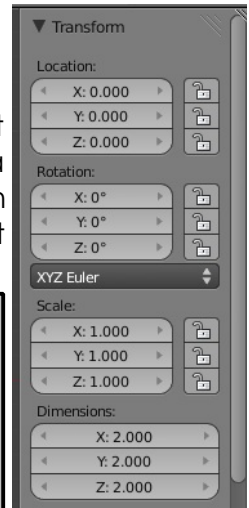
You may be wondering- "*What are these units of measurement?*" By default, you are measuring in Blender Units. The "Dimensions" block is in millimeters by default. We will look at changing this to an actual metric or imperial system later.

Using the Transform Widgets:

Rather than typing R,S or G to manipulate an object, you can turn on the widget feature and simply grab the axis you wish to change. You can also change the motions to reflect Global (normal X,Y,Z planes), Normal or Local (X,Y,Z planes in relation to the object) movement.

Grab directional lines with LMB to manipulate

Widgets On/Off   *Move, Rotate, or Scale*   *Global/Local Settings*

Create a Sculpture

Scenario:
You have been employed to create a digital mock up of a modern art sculpture that uses only basic primitive geometric shapes.

Create a sculpture using at least 1 of every type of mesh found in the <u>*Add-Mesh*</u> menu **(do not use grid or circle)**. ***Remember to make sure you are in Object Mode before creating a new mesh.*** Use a plane for the ground and scale it large. Divide your 3D window into two so you can have one working view and one camera view. Use the RMB to select objects on the screen. Experiment with sizing and rotating objects. New commands:

Size	("S" key)- to change the size/scale of the object.
Rotate	("R" key)- to rotate the object.
Move	("G" key)- to change the location of objects.
Duplicate	(Shift-"D")- to make a copy of something on the screen.
Shaded	("Z" key)- used to toggle the window from wireframe to solid view.
Tool Shelf	("T" key)- shows editing commands and setting mesh detail.
Transform	("N" key)- show the transform panel for exact placement of mesh.

Remember to make use of the number keys 1,3 and 7 to change your principle views!
Also play with the camera location and angle to get a nice view!
Save your work often!
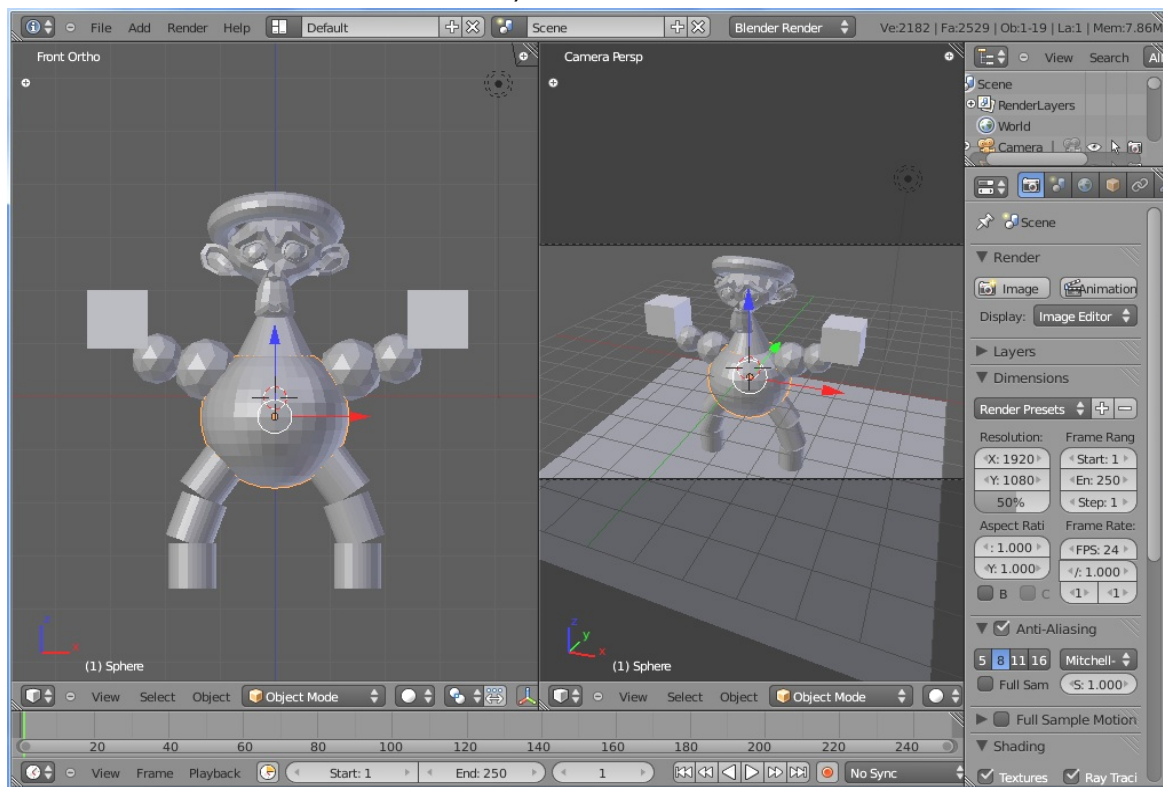
*** You do not have to make a monkey-this is just an example of using the meshes! ***

*** Call the instructor when finished***

Edit Mode- Mesh Editing

Object Mode

After you have created a mesh, you can go into Edit mode (Tab key or Mode option in window) and change its shape. In edit mode, you can work with the shape's individual vertices (mesh intersections) to create the shape you want. You know you're in edit mode when you see pink or yellow dots on the selected object. *Pink* dots are unselected vertices while *yellow* dots are selected vertices.
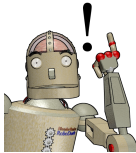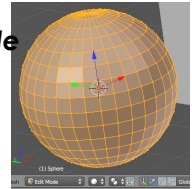
Edit Mode

> *RoboDude Asks: How Do I UNDO a mistake?*
> *Pressing CTRL-Z will take you back 1 step at a time (edit or object modes). CRTL-SHIFT-Z will redo what you undid.*
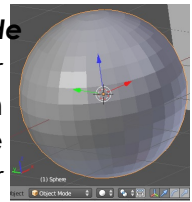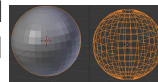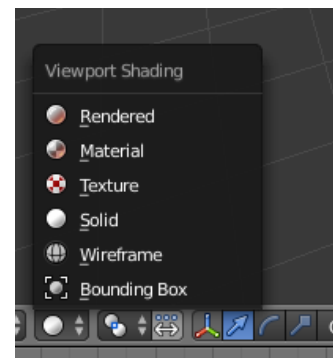
Selecting Vertices:

While in edit mode, to select a single vertex, RMB click on the vertex. To select multiple vertices, hold down the **Shift** key while RMB clicking on them. To drag a window around vertices, type "**B**" key and drag a window to select. Typing the **"C" key** will bring up a circular selection tool that can be sized by pressing the "+ or -" keys on the number pad. Scrolling the center mouse wheel will do the same as "+ and -" keys. To select vertices in circle select mode, hold down the LMB. To de-select vertices, hold down the mouse wheel. Pressing "**Esc**" will get you out of the circular selection tool. **In order to select *all* vertices or deselect currently selected ones, hit the "A" key (for all) once or twice**.

Viewing (Shading) Options:

In order to be able to see your objects better in object and edit modes, you can change the way your scene is displayed. The main options are *Solid* and *Wireframe* and changed with the "Z" key, but other views are available. All are available in the bottom of the 3D window by the drawing modes.
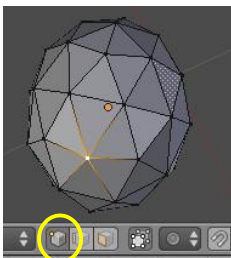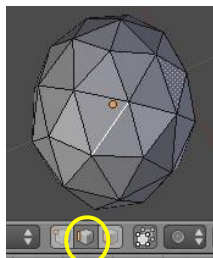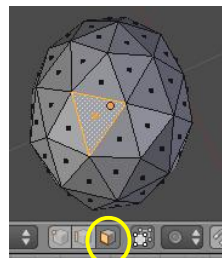
Solid Wireframe

Edit Mode Selection Options:

By default, you are selecting vertices, but you can also select edges and faces. You can find these options at the bottom of the 3D window while in edit mode.

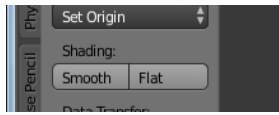*Vertex Select*   *Edge Select*   *Face Select*

In Solid view, this button will hide back faces, edges and verticies. (Occlude background geometry)

After selecting the vertices, you can use the same basic modifiers we talked about in the previous exercise ("**G**"-grab or move, "**S**"-scale, "**R**"-rotate).
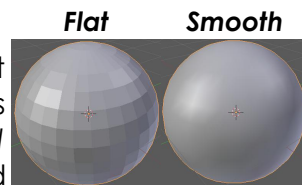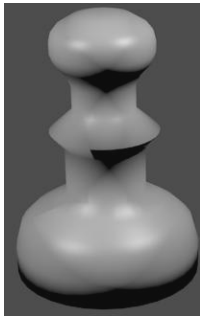
Using the Shading Smooth-Flat Options and Auto Smooth:

Flat   **Smooth**

As you add objects and view them in Flat shading, you will notice that circular objects are not being displayed smooth. In the *Tool Shelf*, you will see two buttons under Shading labeled **Smooth** and **Flat**. These 2 buttons not only effect the way things look on the screen, but how they will be rendered in a final image. **Be aware that the appearance of objects on the screen are not displayed at the same quality as a final rendered image. <u>Auto Smooth</u>** (found in the *Object Data* buttons) is used to smooth objects when faces meet at a certain degree or less while larger angles are kept sharp. This is a great feature when *Smooth* does not work properly alone. To use *Auto Smooth*, hit the Auto Smooth button. Adjust the degree angles as needed. To see a rendered picture of what the camera views, press **F12**. *Smooth and Auto-Smooth are great for flat objects as well and help rendering.*
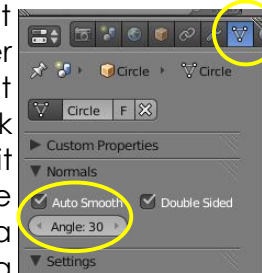
Smooth Only   **Auto Smooth**

Extruding Shapes:

Shapes can be lengthened by selecting a group of vertices, then by pressing the "**E**" key (*or by selecting it in the Tool Shelf*). You will make a duplicate of those vertices. They can then be "G" (moved), "S" (scaled), and "R" (rotated). When extruding a face, it will extrude in a locked direction, perpendicular to the face. When extruding connected vertices only, the extrusion will be free-moving. If you use the "*Extrude Individual*" command in the Tool Shelf, it will extrude only the vertices and no faces (it won't be visible in 3D). Feel free to experiment with them. Below are example of a cube, extruded from the right side (only right 4 vertices were selected) several times using scale and rotate and a pawn extruded from a circle.

Basic Cube
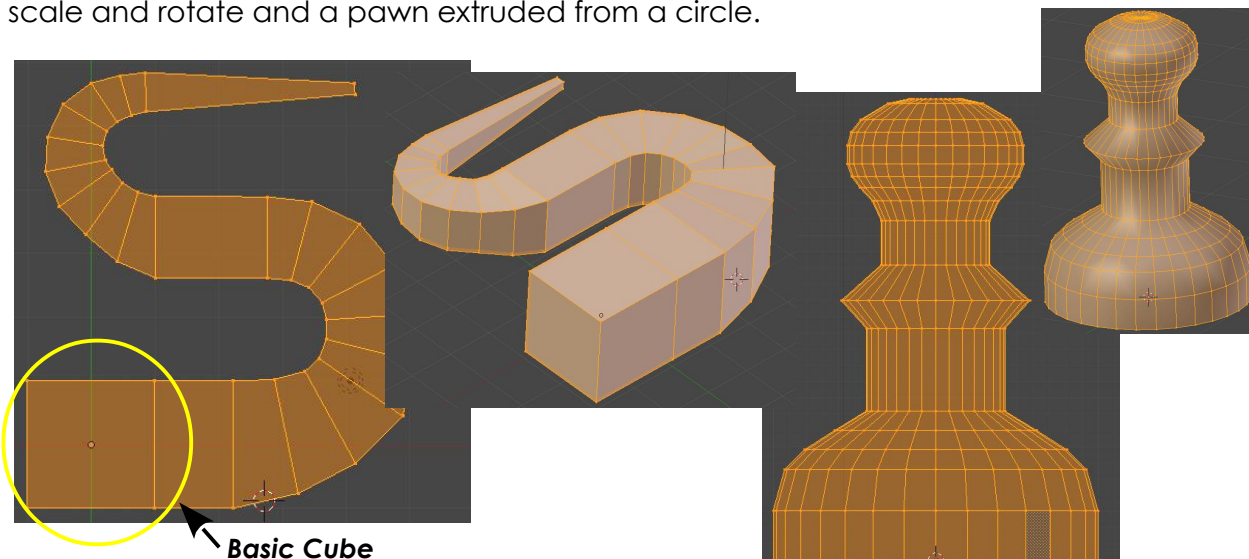
The Tool Shelf

The *Tool Shelf* is one of the biggest changes in recent years and recently improved with tabs. In edit mode, you can access several edit commands with the "**W**" key (*Specials Menu*), but most of these options are now in the *Tool Shelf* as well. The Tool Shelf has different commands for edit and object modes. Here is what you can find in the Tool Shelf and some descriptions of what we need:

Tool Shelf- Object Mode:
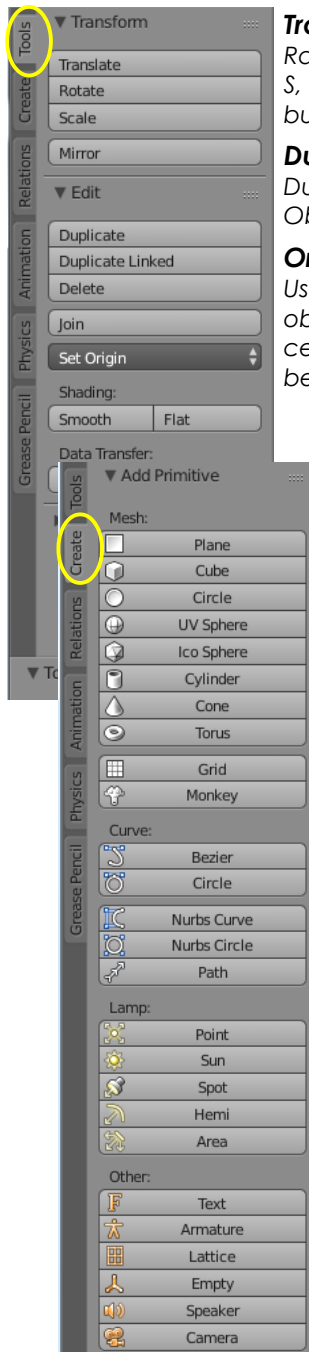
Transform:
Rather than hitting G,R, or S, you can click these buttons.

Duplicate/Join:
Duplicate or Join selected Objects.

Origin:
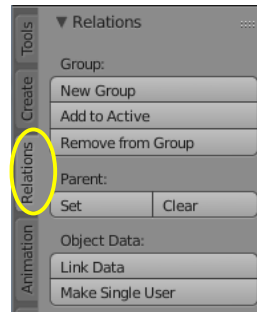*Used to re-center your object's geometry and center point. (see note below)*

Relationships Tab:
Use for linking objects and data together.

Animation Tab:
Create keyframes and set paths.

Create Tab:
Create meshes, curves, lamps, and other objects.

Physics Tab:
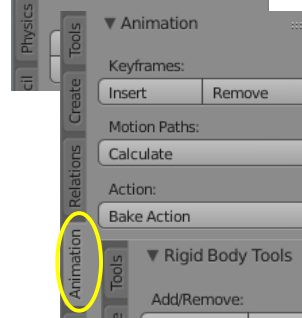*Use for Blender's physics engine and reactions.*

More About the Object's Origin:
The object's origin is the small dot for an object. By default, it is in the middle of the object, but can get moved if you move an object in edit mode (moving verticies only and not the entire object). To fix this, or to move it to a usable location (for example, a door needs it's origin on the edge to act like a hinge), use the origin option in the tool shelf to move the object-to-center, the center-to-object, or center-to-cursor location. Remember that the cursor can be accurately placed using the Shift-"S" command.
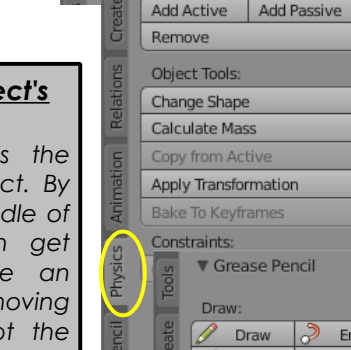
Grease Pencil:
Used to make mark-up notes on your screen.

Tool Shelf- Edit Mode:
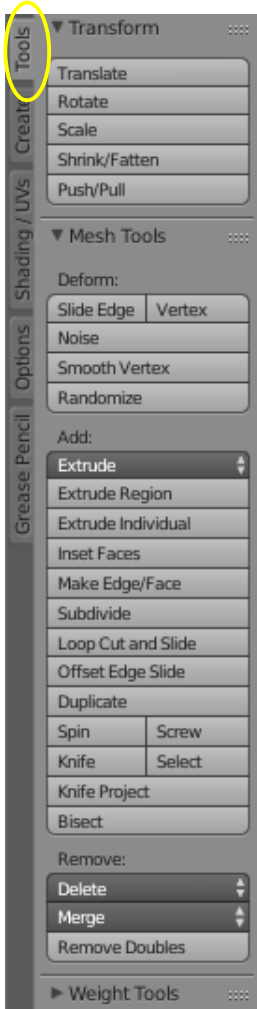
Transform:
Same as Object Mode, but for selected vertices only.

Deform:
Slide Edge/Vertex- moves selected edges and vertices along surface.
Smooth Vertex- Smooths out selected vertices
Randomize- Roughs up a selection

Add:
Extrude- same as hitting "E" with vertices selected.
Subdivide- cuts selected verticies and provides more detail.
Loop Cut/Slide- controlled dividing.
Duplicate- Make copies.
Spin/Screw- revolved copying.
Knife- slices edges.

Remove:
*Deletion options, merging of vertices, and removal of double verticies.*

Shading Tab:
*Smooth/Flat- limits smoothing for selected features.*
Normals- A face has 2 sides and can look odd if they do not all face the same direction Flips face calculations to all face the same way. Helpful with smoothing.
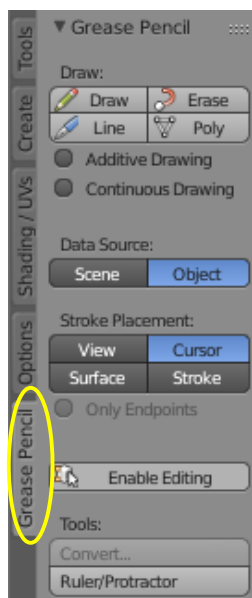*UV Mapping- special texture technique where you can wrap an image onto a mesh. Goof for game design.*
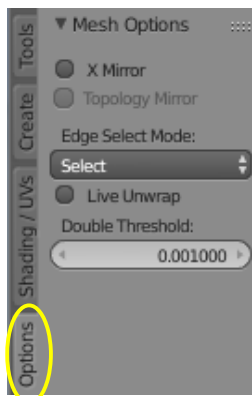
Options Tab:
Set some basic actions like how edges are selected and how close vertices need to be to be considered doubles.
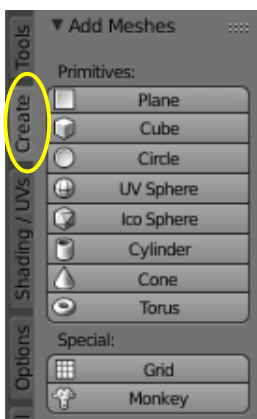
Create Tab:
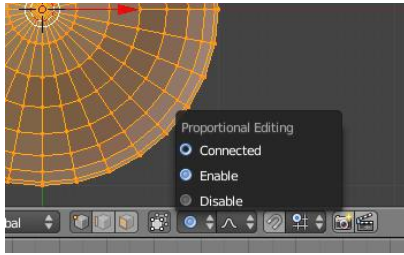*Same as Object mode, except only lets you add similar type items.*

Grease Pencil Tab:
*Same as object mode. Used to sketch on your model.*

Proportional Editing

Proportional Editing is used to create a flow in the shape when editing vertices. To turn proportional editing on, press the "**O**" key while in edit mode or by selecting the **small circle button** on the toolbar (enable). **Proporti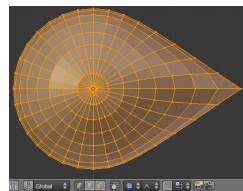onal Editing now also works in Object Mode!** By selecting the prop. editing command in object mode, objects around the selected object will move proportionally with it. You have several options for effecting vertices in proportional editing. We usually use **Sharp** or **Smooth** falloff, but feel free free to experiment with the other options. The examples below are with one vertex selected.
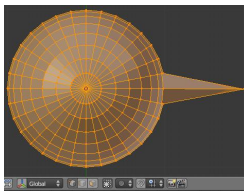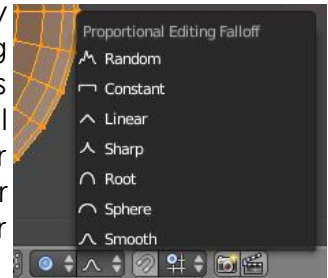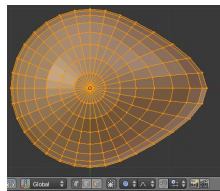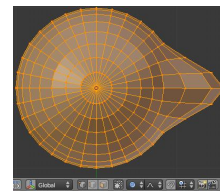
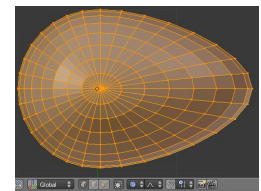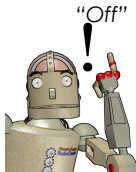|				
Proportional Editing "Off"	*Smooth Falloff*	*Sharp Falloff*	*Small Area*	*Large Area*

> ___RoboDude Asks___: **How do I control the number of verticies affected?**
> *By pressing the "+ and -" keys on the number pad or by scrolling the center mouse wheel. You will see a circle on the screen that changes size.*

Knife/Cut Tools:

The **Knife Tool** allows you to split edges differently than the subdivide command. To use the knife tool, select the vertices you wish to cut, hold the "K" key while dragging a line across the surface you wish to split. You can also select the "Loop Cut and Slide" option in the Tool Shelf to cut around an object.
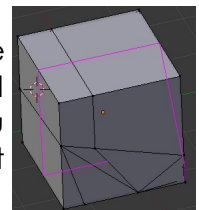
Knife Project:

The **Knife Project** tool allows you to project the shape of one mesh onto another one. This is a great feature when you need a group of vertices that match a specific shape, like text or a circle, that can be extruded or have a different material applied. Here is an example of knife projecting a circle onto a cube. In order to use knife project, select the _projected_ object first (the filled circle in this case), then the object to project onto (the cube) while holding shift. The object will project according to the view you are in, so select the proper view for projecting. Enter _Edit Mode_ (Tab key), and find the Knife Project option in the Tool Shelf under Tools. The mesh will project onto the cube.
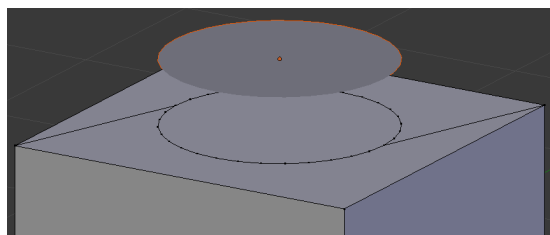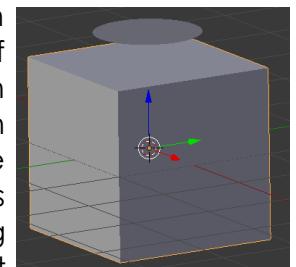
Chapter 3- Creating & Editing Objects

Eliminating Double Vertices and Faces:
One of the biggest problems you can encounter while learning to extrude and shape objects in any 3D program is creating extra vertices and faces as you work. While the problem may not be apparent as you work, problems will occur during rendering or while performing other editing features such as Boolean operations. With experience, you will encounter this problem less frequently.

A very common problem seen in many 3d models, even professionally, is shown to the right called *Z-Fighting*. Z-Fighting occurs when 2 faces occupy the same space and the program has trouble deciding which one to render. The result is typically a darker area on the model.
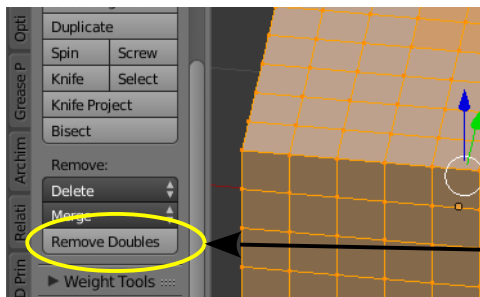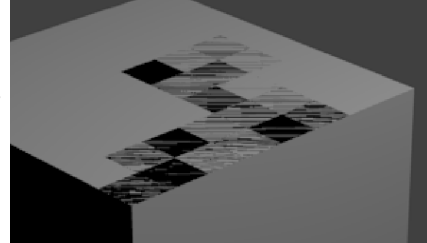
After creating your model, or when you suspect that you have double vertices, the easiest way to remove them is to enter Edit Mode and use the "A" key to select all vertices (*remember that you may need to press "A" twice to deselect and re-select all*). In the Tools tab of the Tool Shelf, find the "Remove Doubles" button. When you press the button, Blender will tell you if and how many double vertices were found in the top bar.
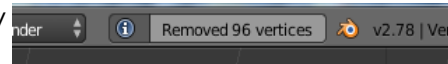
Removing double faces can be a little more difficult. Many times, removing the double vertices will also take care of the double face problem, but not always. Sometime, the double faces will display differently in the view port, making it easier to recognize them. In Edit Mode, switch to selection by **Faces**, select a face you suspect to be double and hit Delete -"*Only Faces*"
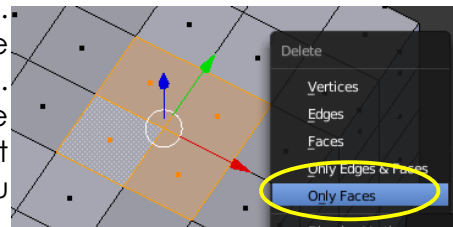
Using Subdivide and Proportional Editing to Create Ground Contour:
You can use proportional editing to create flowing landscape easily. The first thing you need to do is create a plane in the top view (**7 key**). While in edit mode, make sure all vertices are selected (vertices are yellow). You can use the "**A**" key to select them all. In the Tool Shelf, select "**Subdivide**". Do this a few times. Select a single vertex somewhere near center. Next, switch to a front view ("**1**" **key**) and enter *Proportional Editing*. Select *Smooth Falloff*. Type "**G**" to grab (move) the vertex. Use the **"+ -" keys** on number pad or scroll mouse wheel to change the size of the selection.

Select other vertices and falloffs for more hills and shapes. To see your final work in a smooth display, exit edit mode ("**Tab**" key) and ,with the object selected, Select Smooth from the *Tool Shelf*. This will smooth the mesh in display and final output. Finally, hit the "**Z**" key to shade your view.
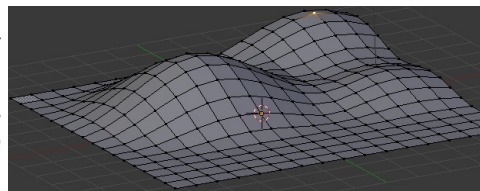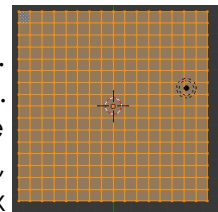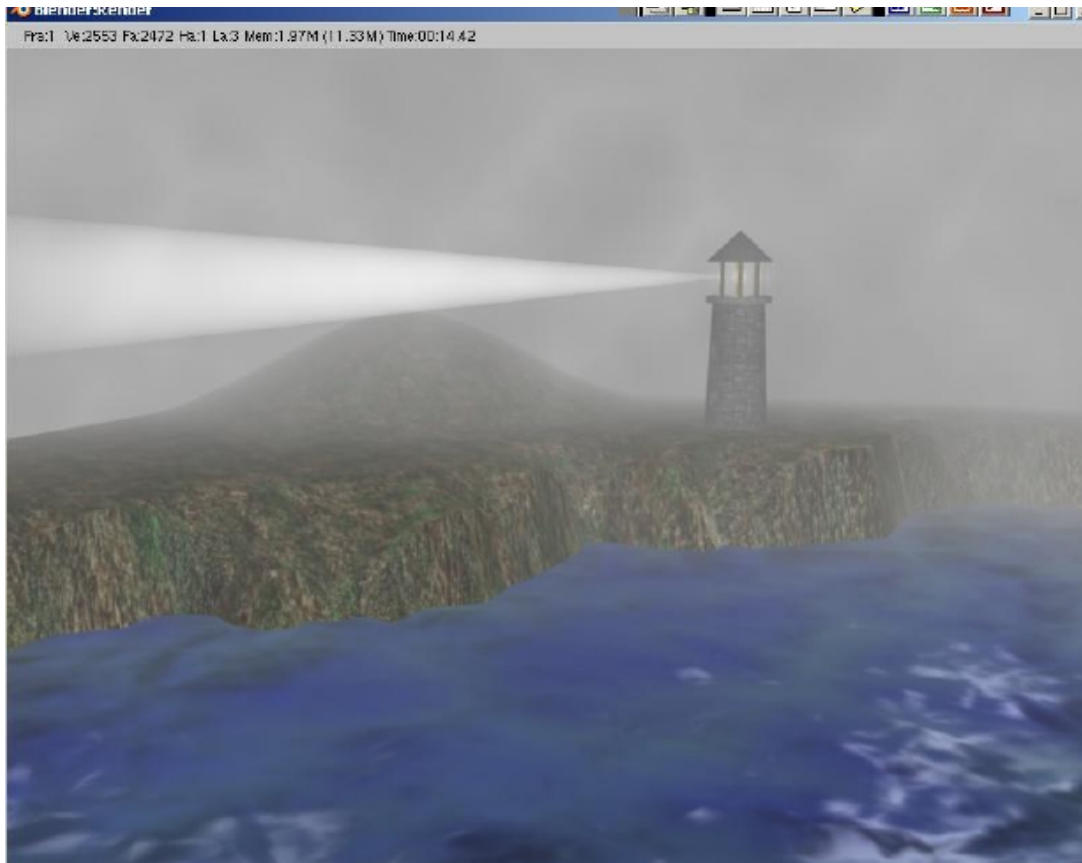
Scenario:
A friend creates YouTube videos for his channel and wants a nice 3D animated lighthouse scene to use as a video production logo. Your job is to create that logo.

This is the basic scene, but as you work through the chapters, you will be encouraged to add more elements and details to your lighthouse and landscape to make it your own. We will eventually add rain to our "stormy night at sea" scene and animate the water, light and camera.

The first thing we need to do is create a new Blender scene and save it as "*Landscape Scene*". Again, we will be using this file for the next several chapters, so keep it safe and *save often*! Change the upper-right viewport from the "Outliner" window type to a "3D View" window type as shown on the next page. We will use the left viewport for working in and the right top one for camera and 3D views. Adjust the viewport size similar to shown.

While in the top orthographic view (*number pad 7 and 5- note the label in the top, left corner*) erase the initial cube from the scene, then add a plane from the mesh menu (*Shift "A"- add- mesh- plane*). For now, you may want to turn off the 3D widgets.

Modeling a Landscape and Lighthouse
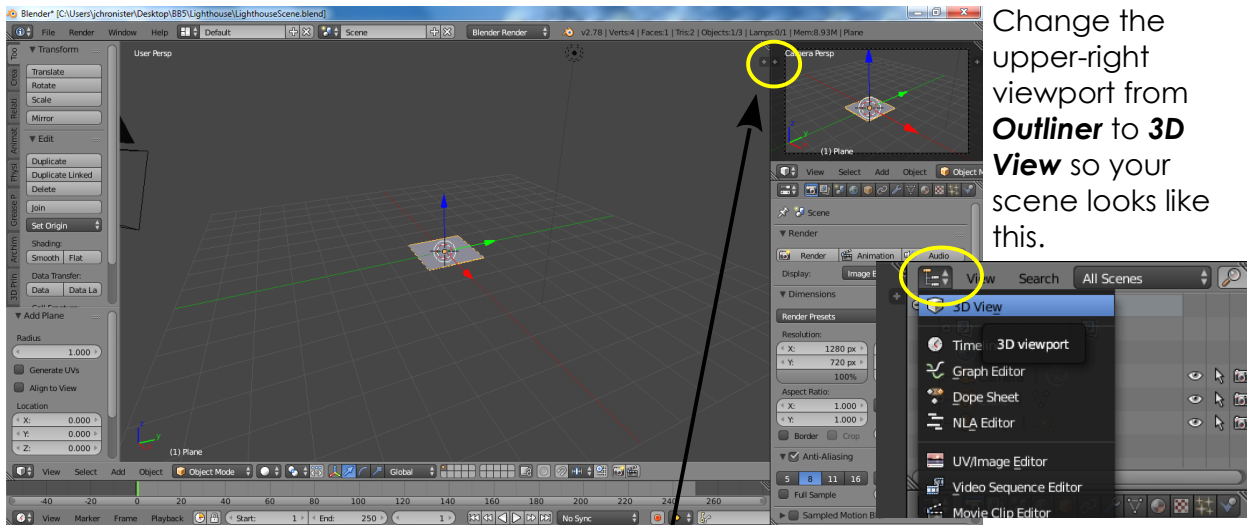
Change the upper-right viewport from *Outliner* to *3D View* so your scene looks like this.

Remember that you can close and open the Tool Shelf and Transform panels at any time. To re-open them, click on the small "+" or type "**T**" for Tool Shelf and "**N**" for Transform Panel. Often, you will be unable to see all of the buttons and panels in the Transform and Tool Shelf bars. Scroll your mouse wheel in the panels to view everything.

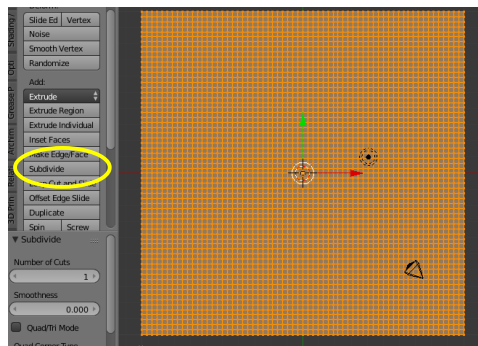The plane you created on the previous page will be used for our ground. Our next step is to scale it up a bit. To do this precisely, we will use the *Transform Panel*. With the plane selected and in Object Mode, press "**N**" to bring up the Transform Panel. Change the **Scale X,Y, and Z to 10.000**. Close the Transform Panel. You may need to zoom out to see the entire plane.
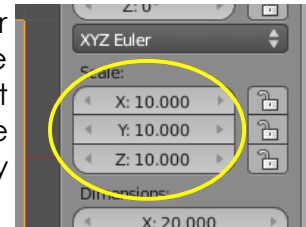
Next, go into E*dit Mode* (tab) and make sure all vertices are selected ("A" key). In the *Tool Shelf*, **click Subdivide 6 times**. Your plane should be well subdivided.

Deselect all vertices using "**A**" and press "**C**" for the circular selection tool. While holding down the LMB, select half the vertices as shown. Keep the edge random similar to what is shown so it looks like a rough shoreline. If you select too many vertices, remember that by holding down the mouse wheel, you can deselect vertices.
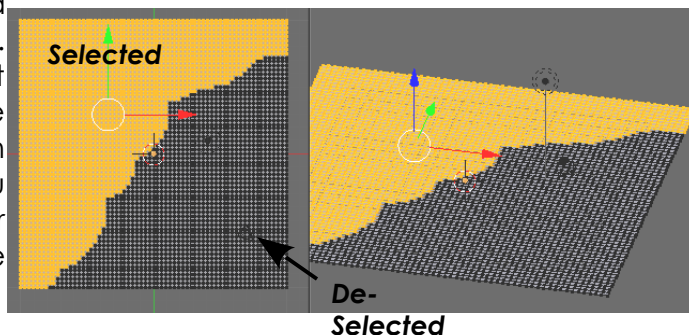
Selected

De-Selected

Now switch to the **front view** (*number pad 1*). Your plane will now just look like a line. Type "**G**" to grab and move the selected vertices. Move them up about 2 Blender grid blocks. You may want to type "**Z**" to keep the move locked to the vertical axis. Use your right side viewport to spin around and get a nice look at the landscape.
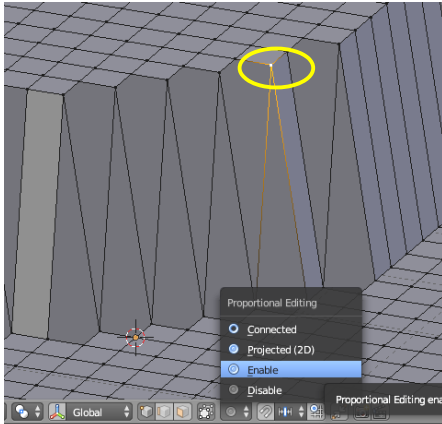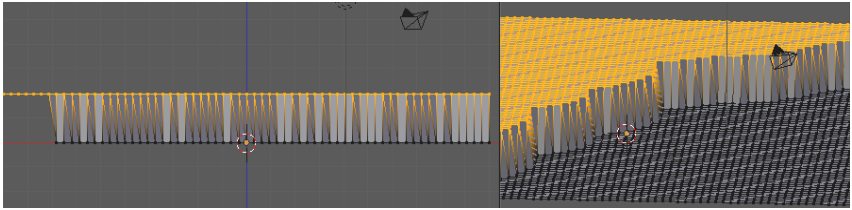
Now it's time to make some fine adjustments to the mesh to make the cliff edge a bit more random. Turn on the *proportional editing* button (small bull's eye button) and experiment with the types of falloff. Select single vertex, "G" to grab and scroll the mouse wheel to change the affected areas while moving. While in the move command, type "Z" to lock to z-axis.

Randomly pull the edges of the cliff up and down to different levels. You may even want to do some of this with proportional editing off. Try selecting a few vertices back on the high flat land and create some hills. *Leave a flat area close to the cliff to place the lighthouse later.*

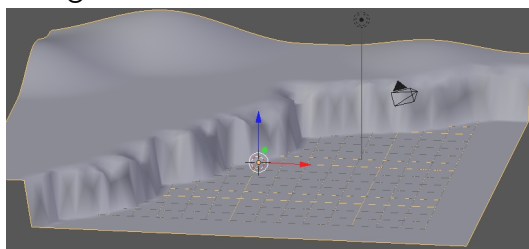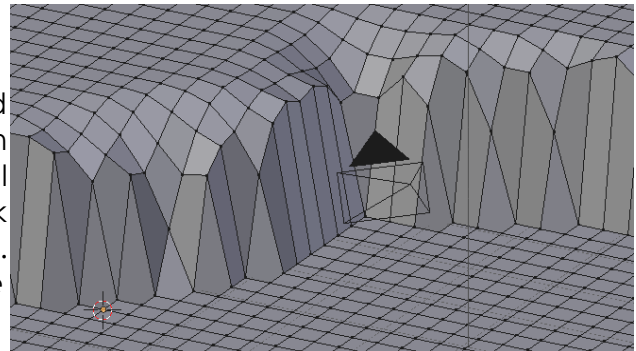The scene's looking better, but a bit angular. Exit edit mode (tab) and find the "**Smooth**" button in the Tool Shelf. Press it and you should see a much better looking landscape *(you must be in object mode to see the smoothing).*

Now it's time to set up the camera. Start by adding an Empty object in the top view (7 number pad key). An Empty is basically used for targeting purposes and does not render as a visible object. *Press Shift "A"- Add- Empty- Plain Axes.* Scale it up a bit.
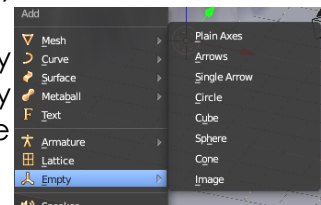
*Now, RMB click on the camera to select it. We will add a Tracking constraint to the camera to always point toward the Empty. With the camera selected first, hold down the Shift key and RMB click on the Empty. Both objects will be highlighted. Press **Ctrl-T** and add a "**TrackTo Constraint**". A dashed line indicates the link. With the camera selected only, move it around- it always points to the Empty. If the link appears to work backwards, it means you had the Empty selected first. Use the UNDO command to back up and try again.*
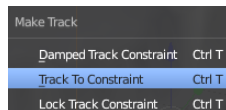
Modeling a Landscape and Lighthouse

It's time to place the Camera and Empty at good rendering locations. You will need to use the move command ("G" key) and place the Empty and Camera using your principle views of Top (#7), Front (#1), and Side (#3). Try to get the camera low so it looks as though you are viewing the shore line from a boat. Place the Empty on the cliff line. Use the picture below to frame up your view. You do not want to see any edges on your rendering. Use the "**F12**" key to render out a picture.
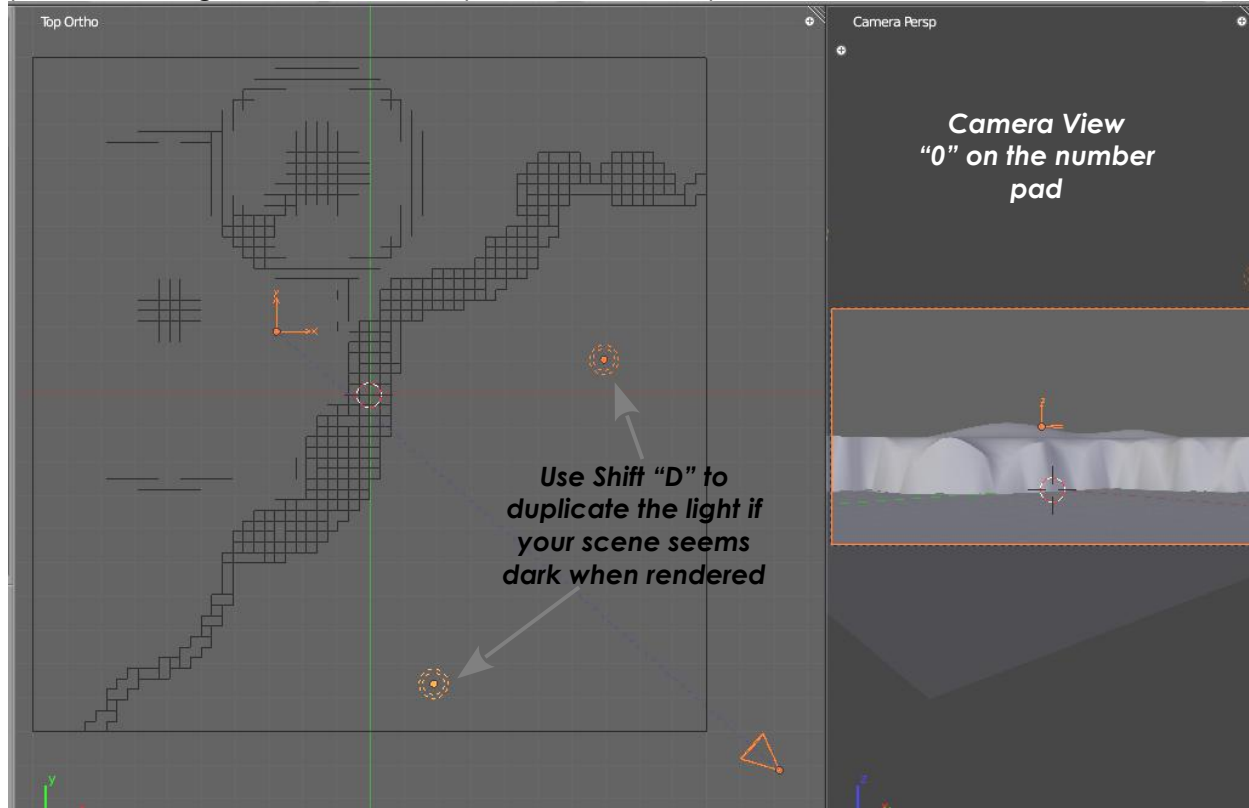
Here is the final render. We're still missing water, textures and a few other things, but it's a good start. Feel free to develop and refine the landscape contour any way you wish. The more time you spend with it, the quicker you will become comfortable with the program and the more realistic it will become.

Save the scene and start a new Blender file (I hope you've been saving every few minutes anyways). We are finished with the landscape for now and will now begin developing the lighthouse as a separate scene that we'll add to the landscape at a later time. Save this new Blender file as "***Lighthouse***".
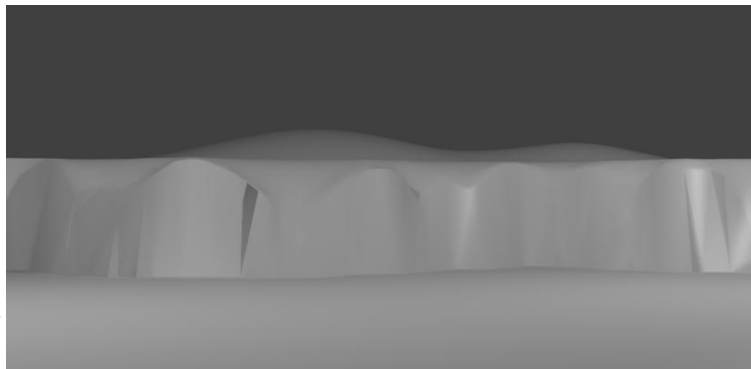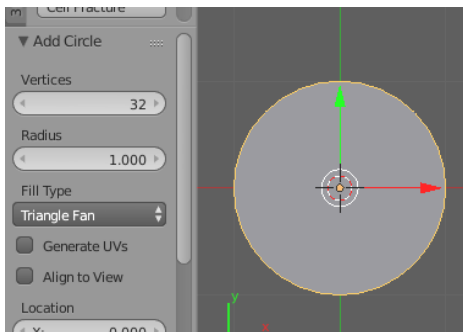
Now it's time to start shaping a lighthouse using the **Extrude** and **Scale** commands. Begin by deleting the default cube and add a **Circle** (*Shift "A"- Add- Mesh- Circle*) in the <u>*Top Ortho View*</u> (#7, 5). Use the default setting of 32 vertices, radius of 1, and <u>*Fill Type- Triangle Fan*</u>. (*found at bottom of the Tool Shelf*). These setting will be fine for what we are making. Depending on what you are making and what it will be used for, you may require more or less vertices.

You will now need to switch to the *Front View* (#1) so the circle appears as a line. Enter *Edit Mode* and make sure all vertices are selected (yellow) and press "**E**" to *Extrude*. If you forgot to add the "Fill" when making the circle, you will need to press the "Z" key as you extrude to lock on the Z axis. If you filled the circle, it will extrude on the Z axis automatically. Extrude the lighthouse about 3 Blender grid blocks high and LMB click to place them. Hit "**S**" to *Scale* them in slightly. This is your lighthouse- feel free to adjust sizes as desired. <u>*Remember to stay in the front view throughout this process!*</u> Rotated views can cause a distorted lighthouse.
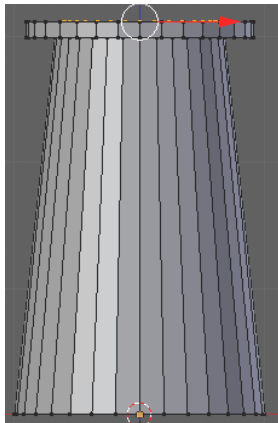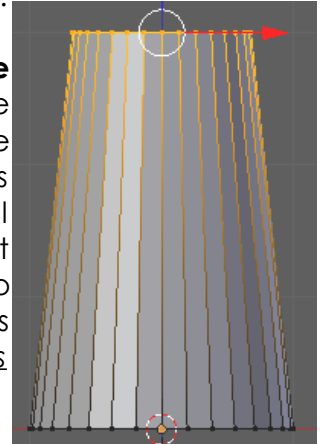
It is now time to make the small walkway around the top. Press "**E**" to extrude again and <u>*right mouse button*</u> (RMB) click. This will place the new extruded vertices right on top of the old ones. Then "**S**" to scale. Pull your mouse away from the lighthouse and scale the walkway outward as desired. LMB click when you have a good size. Remember, you can always UNDO (Ctrl-Z) if it doesn't seem right. Extrude again to give the walkway some height. You will then Extrude, RMB and Scale again to reduce the size back inward.

Continue extruding and shaping to get the light area and the roof. The point of the roof will actually have 32 vertices which you could scale very small so that it appears to be a single point, but we will use a Tool Shelf command to correct this. Select the "**Merge**" option and "**At Center**". You will see that 31 vertices are being removed, leaving only one at the center.
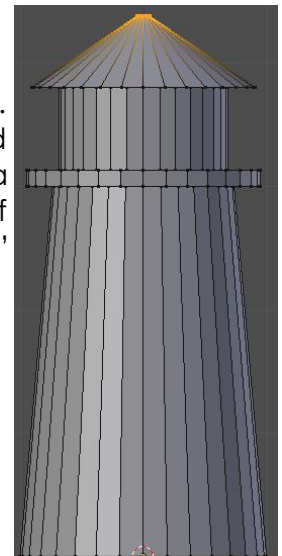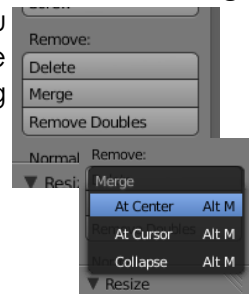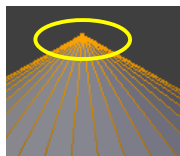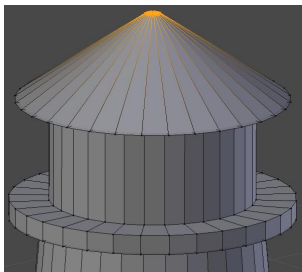
Modeling a Landscape and Lighthouse

Exit *Edit Mode* for the lighthouse then select and move your *Camera* to a location that displays the lighthouse well and press "**F12**" to render an image. The lighthouse looks good, but angular. It will take more than *Smooth Shading* to make it look good. Some edges actually need to stay sharp. This is where *Auto Smooth* becomes important.
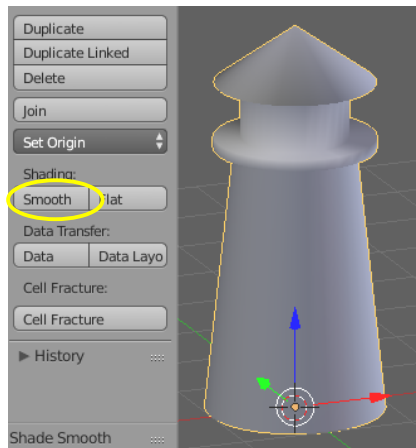
Select the lighthouse again. In the *Tool Shelf*, select the "**Smooth**" button under shading. Ignore how the lighthouse look on the screen. Render a picture with "F12" to see the results. Some things are smooth that should remain sharp (and some other strange edge effects). Go to the **Object Data** buttons and find the "**Auto Smooth**" button. You will notice a degree angle below the Auto Smooth button. Leaving it a the default of 30 degrees should work well, but feel free to experiment with other setting. Basically, this setting determines which faces are smoothed and which ones are kept sharp.
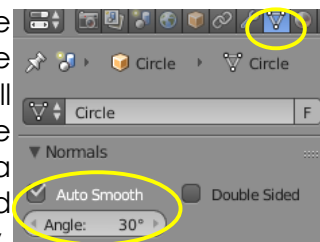
Finally, press "F12" to render a picture and check your results. If you haven't saved your file, do so now and remember to save often. We are finished with our lighthouse for now. If you have the time, feel free to modify the lighthouse, change the style, add more features, etc. A good possible addition could be to use *Torus and cylinder* meshes to create a railing around the walkway. Remember, the Torus mesh features can be adjusted in the bottom half of the Tool Shelf.
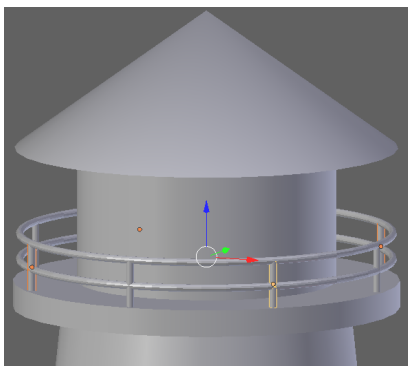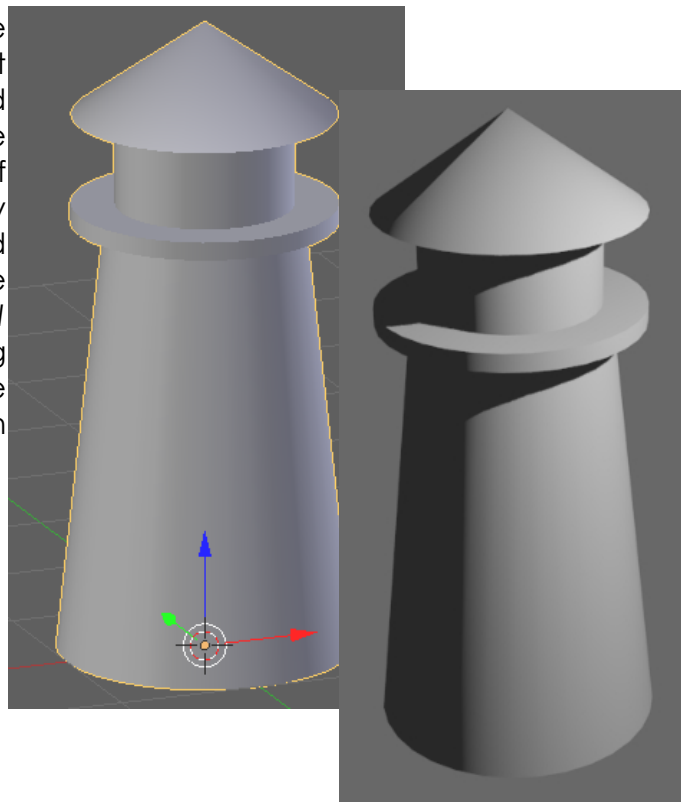
*** Call the instructor when finished***

Joining/Separating Meshes and Boolean Operations

Now that you have some experience with basic editing, here are few more options:

Joining Meshes:

To join 2 or more meshes together, Hold down the **"Shift"** key to select them, then press "**Ctrl**" and "**J**" to join them. They will retain any materials you have placed on them, but will be one object. *Also available in the Tool Shelf*.
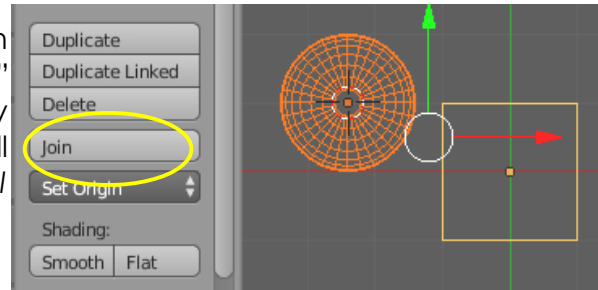
Separating Meshes:
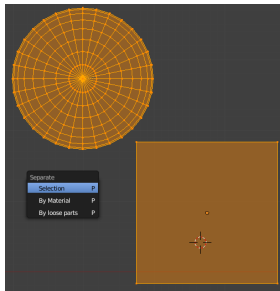
In order to break up a mesh, you need to be in edit mode (**Tab** Key) and select the vertices you wish to separate from the rest of the mesh. With vertices selected, type the "**P**" key (I like to think of it as *partition*) and select your option. You also an option to separate *all loose parts*.

Deleting Vertices, Edges, and Faces:

If you want to make a hole in a mesh, select the vertices, edges, or faces you wish to remove, then hit the "**Delete**" key. Select the option of what you wish to delete.
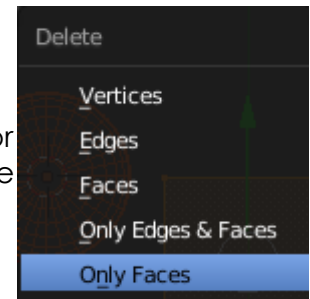
Adding Faces:
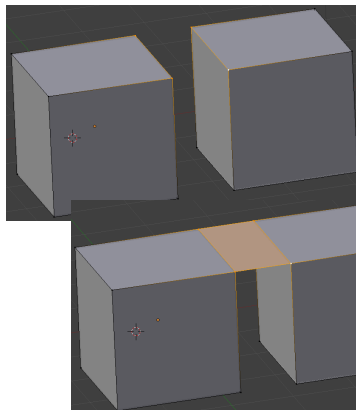
Sometimes, you need to fill in holes in a mesh by creating your own faces. To do this, go into edit mode and select the vertices you wish to face together (you are limited to 4 vertices in a group). With vertices selected, hit the "**F**" key. A face will be formed. Here is an example of 2 cubes joined together with a space that needs filled between them. In edit mode, select the 4 vertices (hold down **shift** key and **right click** on them), then type **F**. A face will be created. **Ctrl-F** will give a *Face Specials* menu of options that will allow a larger set of closed vertices to be faced with additional options. Using **Alt- F** will fill a larger area automatically.

RoboDude Says: Adding and deleting faces and vertices are the basics in any model construction. It is important to become comfortable with these operations while knowing how to accurately work within your viewports.
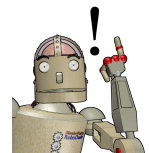
Boolean Operations:

Boolean operations allow you to cut or join meshes by using other meshes. In other words, A mesh can be made combining 2 meshes different from the *Join* command. When using *Join*, the 2 shapes still retain all vertices. When using Boolean, a new shape is calculated (*union*) and removes interior geometry. A mesh can also be used to cut a hole in another mesh (*difference*) and a shape can also be made from where the 2 shape intersect with one another (*intersect*).

In the sample shown below, a cube and a sphere have been placed overlapping each other. With the *cube* selected, we will be applying a *Boolean Modifier*. This is the first time we have accessed the *Modifier* buttons. If the resolution of your computer if not set so that you are able to see the Modifiers button, hold down your mouse wheel to scroll over the buttons to gain access to it.

Click on the "**Add Modifier**" button. You will see a variety of modifiers that can be added and many will be discussed later. For now, select the **Boolean** modifier.
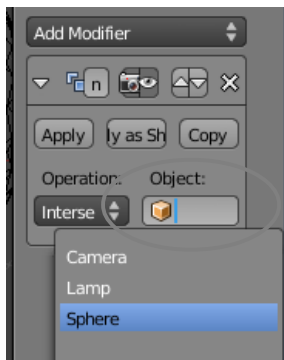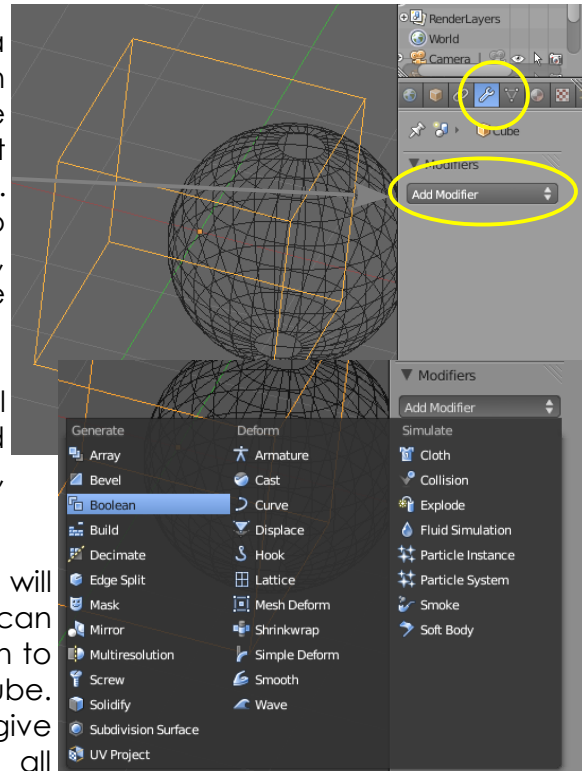
In the Boolean panel, you will see a block where you can select the object you wish to use to modify the cube. Clicking in the box will give you a drop down of all objects in the scene. Selecting the sphere will display the changes to the cube. Below, you can see what each option will display:
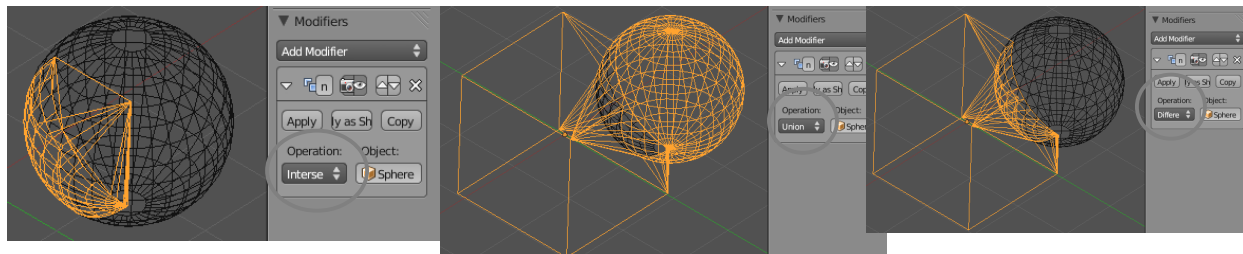
Intersection (what is shared)   *Union (joins the meshes)*   *Difference (subtracts the mesh)*

By hitting the "**Apply**" button, the new shape becomes set and the sphere can be removed.
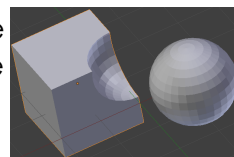
To begin this exercise, start by opening up your **_Lighthouse_** file from the previous exercise. We are going to use Boolean operations to cut some simple windows in your lighthouse.

Begin by adding a **Cube** (*Shift "A"-Add-Mesh-Cube*) to your scene and scale it to an appropriate size and shape. Using your principle views of #1,#3, and #7, place the cube in a good location for a window. With the cube still selected, make note of the cube's name, displayed in the lower left corner of the viewport. We will need to know that name later. The name can also be changed in the Transform window.
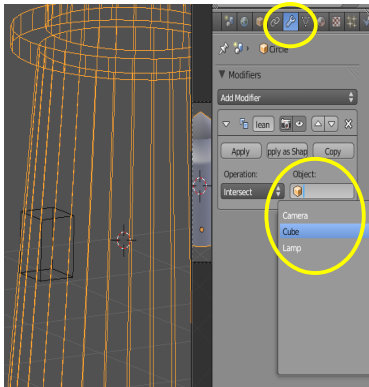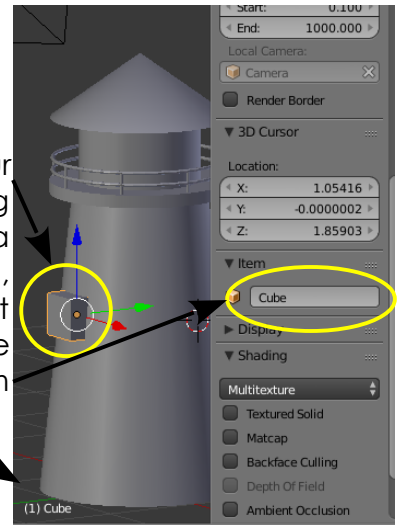
Now select the _Lighthouse_ and enter *Wireframe* view ("Z" key). Go to the _Modifiers_ Panel and add a _Boolean Modifier_. Select the _Cube_ from the list under *Object*. By changing the *Operation* from "**Intersect**" to "**Difference**", you should see a cut in the lighthouse to match the cube. Hit "**Apply**".
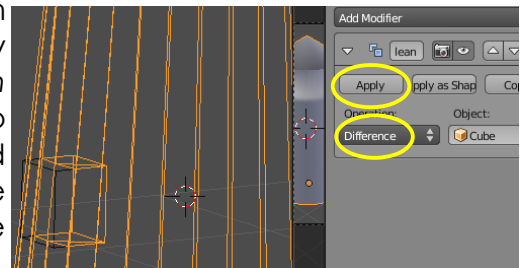
Now you can move the cube to a different spot and add another Boolean modifier to cut another window using "**Difference**" and "**Apply**". You can even use different mesh shapes to cut other window and door shapes. Press "F12" to see a rendered view of your results.

Remember to add the Boolean Modifier to the lighthouse and not the cube!

** Call the instructor when finished**
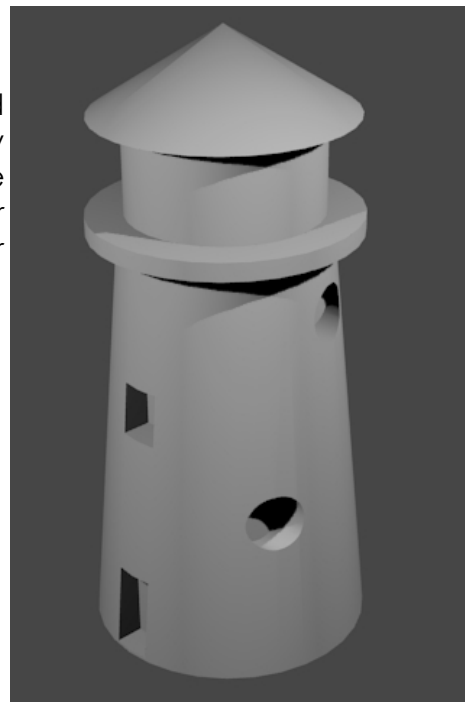
Challenge Task- Logo Design

Scenario:

A local company or sports team wants you to design an animated logo for them. They need the logo to be 3D and useful for their promotional needs.

For this exercise, you will be creating a 3D logo for a favorite team, company, product, or school while using many of the techniques discussed in this chapter. Your first step is to do an internet search for an image you wish to model from. I will be using a Blender Logo for my example. Save that image on you computer, then in Blender, erase the initial cube and open the *Transform Panel* if not already open on the right side of the window (*"N" key or the small "+" in the upper right corner of the window*). Scroll down the list and find the "**Background Images**" panel. Check the box and open the panel. You will see an "Open" button that will allow you to load your image. Load your image and it should show up in the background of the 3D window.
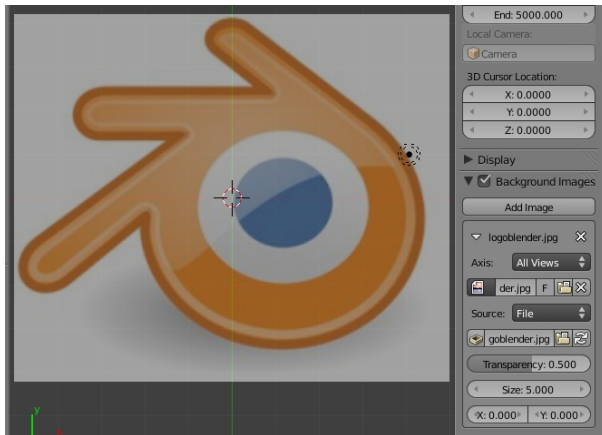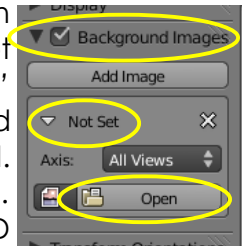
The image will only display in a principal ortho view (7,1, or 3- 5 key switches between ortho and perspective). You will notice that you can control which views the image displays in, if you want to display a movie or image as a background, the transparency of the image, the size and X,Y offset.

Make sure you are in the *Top Ortho View* and create a *Plane* from the *Add-Mesh* menu. Go to *wireframe* view ("Z" key) and *Edit Mode* (Tab key). Delete 1 vertex so all you have are 3 vertices.
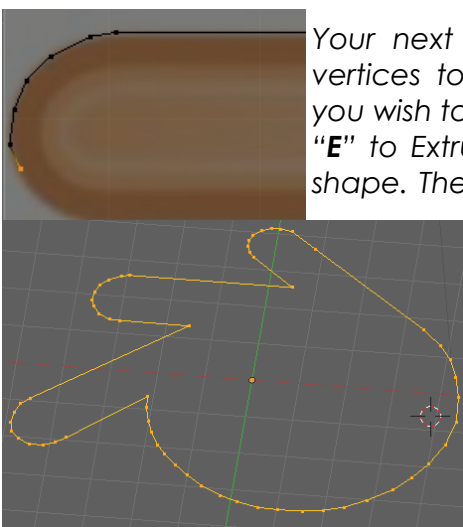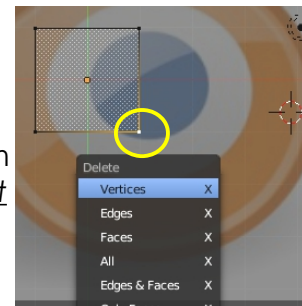
*Your next step is to move the 3 existing vertices to the edge of the shape where you wish to start. Select an end vertex, press "**E**" to Extrude and continue outlining your shape. The more care you take in shaping, the better the logo will look. Continue around the shape until you get back to the beginning. While holding down the Shift key, press "**F**" to Face. This will connect the 2 ends and close the shape. You will now have the basic shape.*
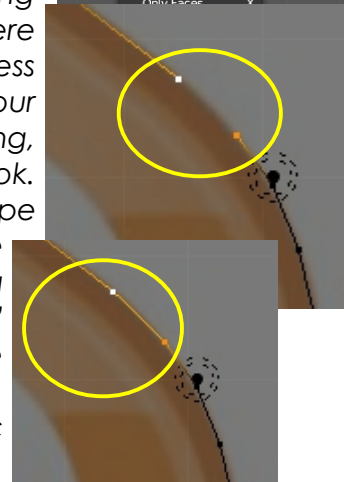
The next step is to create the inner edge of the shape. To do this you need to <u>copy</u> (*not extrude*) a vertex over to the inner edge (*Shift-"D"*). From there, continue to extrude and close the inner edge as you did with the outer edge. Notice that the Blender logo also has a blue inner circle. We will also copy and extrude a circle for that ring. If you have other details to add, do that at this time. *Always stay in the Top View!*
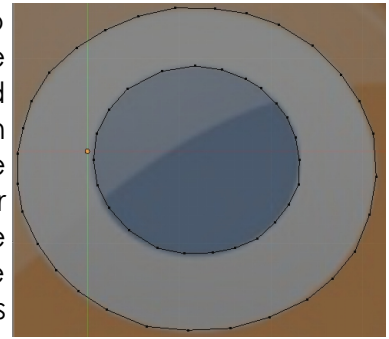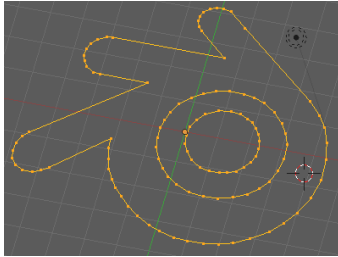
Before we face the mesh, we will need to separate the vertices into different meshes that will receive different materials. Select those vertices using the "**B**" or "**C**" commands and hit "P" to *partition or separate* them from the main mesh. For my example, I will select the inner ring that will get a blue material. After separating all the vertices, go back to *Object Mode*.
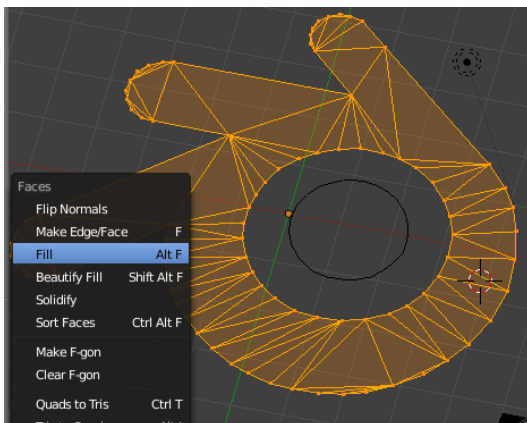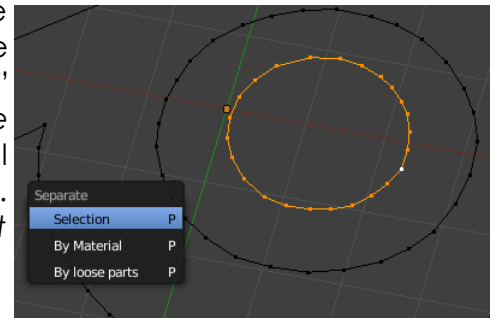
It's now time to face the mesh. We could select 3-4 vertices at a time and hit "**F**" to face them, but that would take a long time! Instead, we will use the **Ctrl-"F"** menu. First, enter <u>Edit Mode</u> for one of your meshes and make sure all vertices are selected (*"A" key*). Hit **Ctrl-"F"** and select "**Fill**" (*or* ***Alt-F*** *to save a step*). If the shape is complex, not closed, or has double vertices somewhere, this option may not work and forces you to find the problem or face it manually. Once it is filled, you may want to go back into the Ctrl-"F" menu again and select the "**Tris-to-Quads**" option to convert triangles to quads for less faces and a cleaner look. Do this for all meshes, then switch to the <u>Front View</u> and <u>Extrude</u> the meshes to a desired thickness, like you did with the lighthouse.
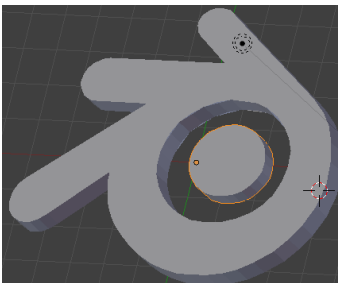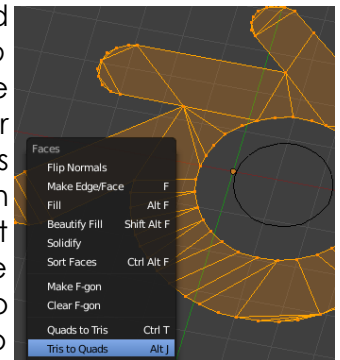
You logo is finished for now. We will not be addressing this as an actual exercise, but after reading the chapter on <u>Materials and Textures</u>, you can come back and add color to your logo.

*** Call the instructor when finished***

Chapter 3 Reflection and Wrap-up:

Creating & Editing Meshes

This was a long chapter with a lot of information provided, but being able to create basic shapes in Blender is a primary skill. There are still a lot of commands and techniques to learn to improve your 3D modeling skills and many of these will be addressed in future chapters, however, practice is the key to become a skilled artist. Answer the following questions in as much detail as possible.

1. Your first task in this chapter had you working with basic meshes, trying to create a sculpture, much like you would have used building blocks as a child. What was your biggest challenge then and how would that challenge be different now that you have completed the chapter and have a little more experience? Explain.

2. How did your lighthouse and landscape turn out? Are you pleased with your results? What was the most difficult aspect of that project and how did you overcome that challenge? Explain.

3. The logo challenge activity is designed to have you create a 3D logo much like ones you would see at sporting events, in movies, and on T.V. Find a 3D animated logo on the internet that interests you. Do you have a better understanding now of how a logo like that is made? How has this chapter shaped your understanding of 3D modeling? Explain.

4. Have these activities inspired you to create any projects of your own? What would you like to create?

What is a Render Engine?

As you make your 3D models in Blender, your goal will probably be to generate (render) an image or a movie as a final result. The software that determines how your scene will look is the render engine. The render engine will need to know how to handle materials on your objects, how the lighting in your scene should react with reflections, refraction, bounced ambient lighting, shadows, etc. While there are several 3rd party engines out there that can work with Blender, there are actually two engines built into the program: the classic <u>internal renderer</u> and the newer <u>cycles</u> renderer. Every render engine will generate different results depending on how it calculates the scene. Some render engines will take a lot longer to generate an image than others. Cycles handles lighting much better than the internal renderer, providing more realistic results.
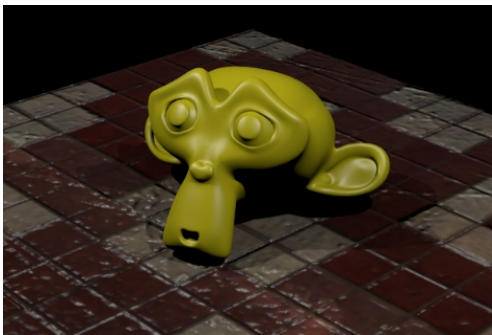
Classic Render Engine
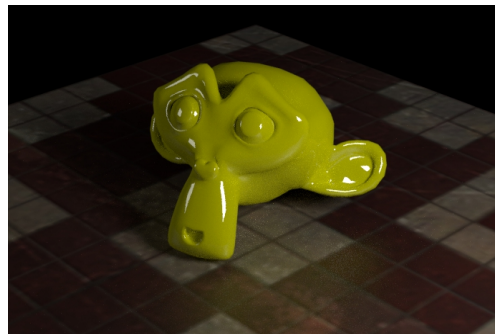
Cycles Render Engine- 128 samples

So which one do you use?

That will depend on what you want for results. The classic internal engine will give you faster results, but with less realism. The cycles engine will give you more realistic results, but requires more set up time and much longer render times, depending on your computer and graphics card (*possibly minutes as opposed to hours*). **Because this book is written for use in the classroom, all of the activities here use the <u>classic render engine</u>.** Time is a valuable commodity in school and we need to render as quickly as possible to meet deadlines. Like most schools, we do not have the best video cards on the market, making cycles a tough choice for us. Cycles is a work in progress and getting improvements with every new release. Some students do choose to use cycles. In this chapter and the next, we will discuss the basics of the cycles renderer and how to set up basic materials. With that knowledge, you can decide which render engine you would like to use for the activities. Both render engine will give you great results!

The Classic Render Engine:

Currently, by default, the classic "Blender Render" is active when you launch Blender. You can change this in the top header to "Cycles Render" or "Blender Game". The Blender Game engine rendering will be discussed in

a later chapter. For now, stay in "**Blender Render**". We will discuss "Cycles Render" later.
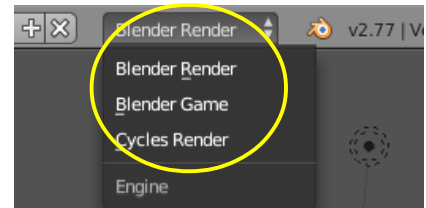
Chapter 4- Blender Render Engines

Materials and textures are what change your model from being gray to brilliant. We will only discuss some basic material settings in this chapter so you can experiment with the render engines. Materials will be detailed in the next chapter. *Remember, we are focusing on the **classic internal renderer** right now.*

Basic Material Settings

To add a material, first select the object you want to work with, then go to the **Materials** panel in the **Properties** window. Click the "**New**" button *(unless you are working with the initial cube- that has a material on it by default)*. You will see more options open up. Right now, we are only interested in changing *color* and *glossiness*.
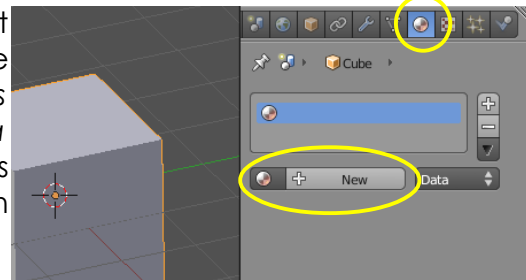
Diffuse:

Diffuse is actually the color that is given off by the object- the color you see. If you want the object to be red, set it here. You will also see settings for the way the material is calculated (default-Lambert) and the intensity slider. The Ramp button will allow diversity of color.
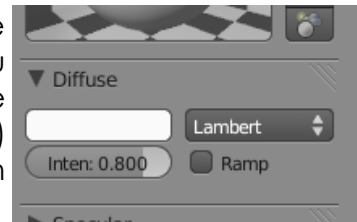
By clicking on the color sample in diffuse (or in any other block dealing with a color), the color wheel will pop up. You can set the color using the wheel and light/dark slider, setting in manually using RGB, HSV, or Hex numbers. You'll also see an eyedropper for picking a color elsewhere.

The Preview panel can be used to see the results of your setting changes. You can also change the default sphere preview shape to something else.
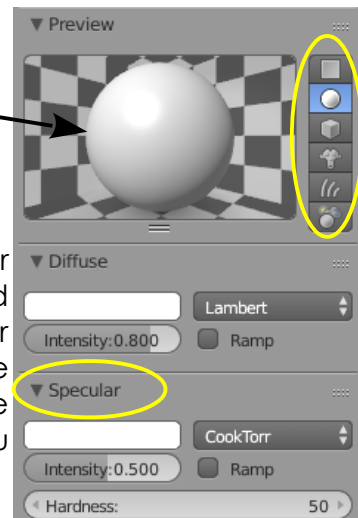
Specular:

Specular settings control the *glossiness* of the object (is it flat or shiny?) You will see a color sample, calculation model and ramp as in Diffuse. The color sample indicates the color reflected back (usually kept white). Intensity controls the amount of glossiness while the hardness slider controls the hardness and softness of the glow. Check the sample as you change these settings to see how it changes appearance.
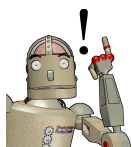
> **RoboDude Asks: How can I see all the panels on the screen?**
> *It is impossible to see all of the panels at once, but you can scale the by pressing the "+" and "-" keys on the number pad and pan with the mouse wheel.*

The Cycles Render Engine:

As mentioned before, you have a second option for rendering your projects. While the classic render engine is still the default in Blender, *Cycles* continues to receive most of the recent development and will likely become the default renderer in the near future. Since cycles can produce more accurate results with reflected light and other effects, it is more memory and is processor intensive. This is where your computer hardware makes a big difference and a place where many high school labs can fall short. In our lab, we have fast dual-core computers, loaded with RAM, but with integrated video cards. Due to school district budgets, I think many schools are in the same boat. Because of this factor, we can render simple scenes in Cycles, but as scenes become more complex, we experience problems and need to rely on the classic renderer. Render farms, or *Network Rendering*, (discussed in Chapter 8) can help you get through larger projects as well. Expect detailed project in either render engine to take minutes to hours to render a single image as you add more detail.

To access the Cycles render engine, switch from "Blender Render" to "Cycles Render" at the top of the screen.

CPU or GPU?

By default, Blender and Cycles use the **CPU** (the computer processor) to render your project. Because the CPU is doing everything to run your computer, the amount of memory and the processor speed of your computer will dete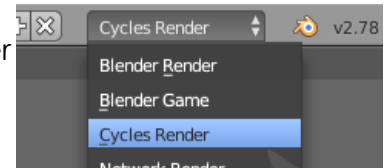rmine how fast your projects render. Newer computers have fast video cards, or **GPU** (the graphics processor) and Cycles can be set to use the GPU instead of the CPU. If your computer supports GPU, you can experiment to see which one works best for you.

To see if you have a choice between the two, go to the "*File*" menu- "*User Preferences*". Under the "*System*" tab, find the "Compute Device" options. If you see an option of CUDA or OpenCL, the you have GPU rendering. If not, you are limited to CPU rendering. You can try to update drivers, update your video card, or live with CPU rendering. You will also need to select CPU or GPU under "Device" in "Properties".
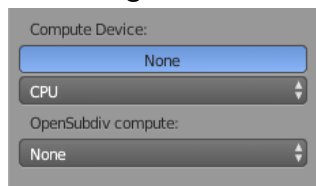
System option in Preferences menu with CPU support only.
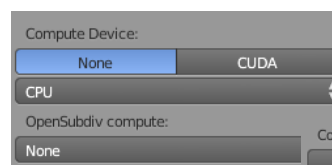
System option in Preferences menu with CUDA GPU support.
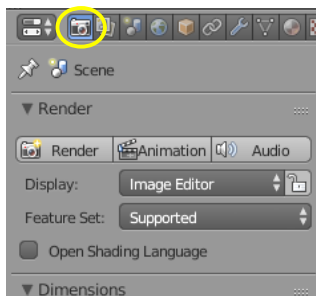
Render settings for Cycles in the Properties window. No option for "Device" when GPU is unsupported by your computer.
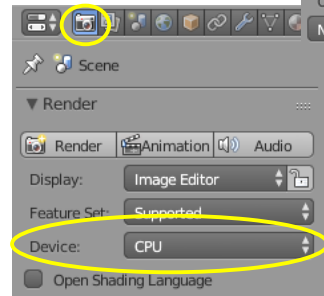
Render settings for Cycles in the Properties window. There is a "Device" option for you to select between CPU and GPU when your computer support GPU rendering.

Chapter 4- Blender Render Engines

Node-Based Rendering:

Cycles rendering is entirely different than classic rendering in that Cycles is node-based, or rather blocks, designed to be connected together to produce your results. Nodes can be confusing to work with, but you can set up your basic materials and textures in the Properties window, similar to the way we construct them with the classic renderer to make life easier. You can then adjust your results by adding and adjusting nodes in the Nodes window. As you work with Cycles, this will become easier. With a little research on the internet, you will find a lot of tutorials for creating specific effects with nodes.
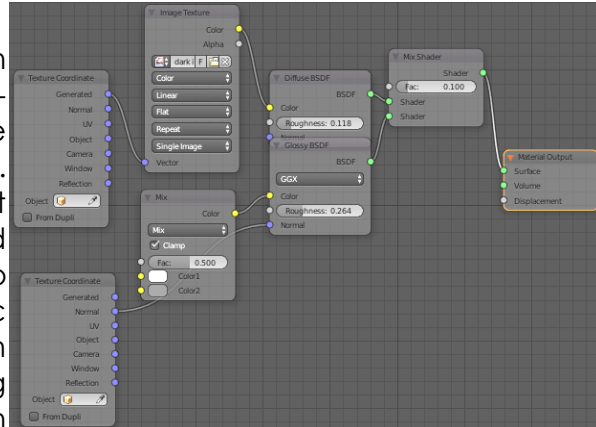
In-Viewport Rendering:

A nice feature of Cycles is that you can view your render results in the viewport without the need for pressing F12. While this feature also works to some degree in the classic rendered, you can control the results better in Cycles. If you press the shading button at the bottom of the 3D View window, you can select "Rendered" from the list of options.
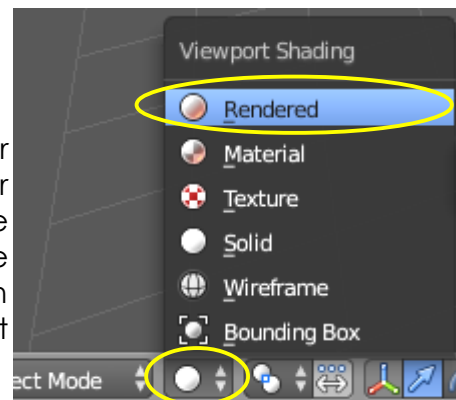
Cycles Render Quality Control- Samples:

Cycles renders will look grainy by default. While the complete explanation is complex, what is essentially happening in Cycles is that the image quality will continue to improve over time with each sample and you can control the number of **samples** (*found in the Render Properties menu*) in the viewport and in the final render (F12). Usually you want a lower "Preview" sample number for faster work in the viewport and a higher number for the final "Render". Depending on your computer speed and the complexity of the scene, the higher the better, but you need to find a balance of quality and time. Professionals may render samples in the thousands.
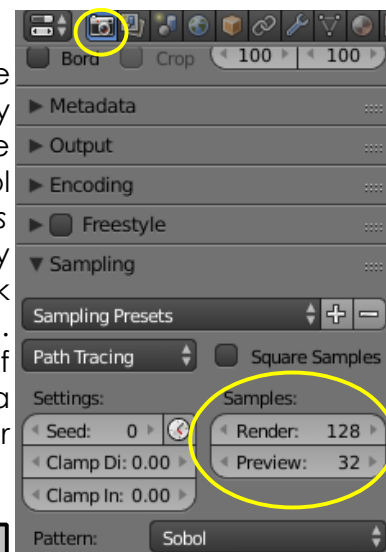
> ***RoboDude Asks:*** *Why is Blender running so slow in Cycles?*
> *If you have your viewport in "Rendered" view instead of "Solid" view and the "Preview" samples set too high, you will be limited in what you can do as it process the samples. Try a lower sample rate.*
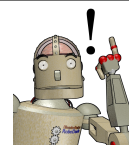
Lighting in Cycles:

We will look at lighting settings more in chapter 7, but basically, to illuminate your scene correctly in Cycles, you will not be able to use traditional Blender lamps adequately. Cycles uses mesh objects, set to "Emission" in the material settings. This is because traditional Blender lamps project from a pin-point location where real lamps project from larger areas, like a light bulb would project more from a spherical object. Planes work great to light Cycles scenes.
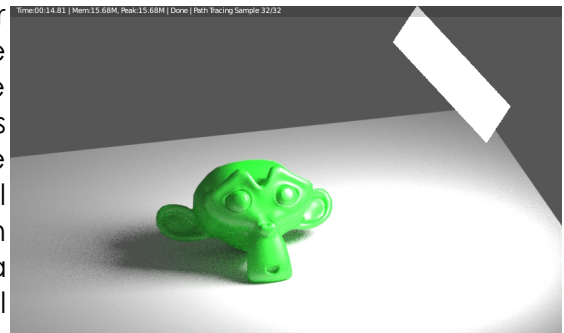
Basic Material Settings in Cycles:

As mentioned before, Cycles is a node-based render engine, but we can use the *Materials* properties panel to do some basic setup, similar to the classic render engine. After switching to the Cycles renderer, adjusting your processor (CPU or GPU), and setting the Samples, you are now ready to apply some basic materials.

With the object selected, go to the *Materials* property panel. You will notice settings are presented differently than in the classic renderer. Start by pressing the "**Use Nodes**" button.
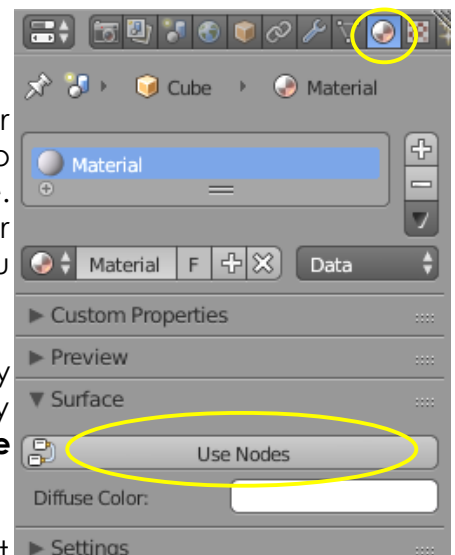
By default, you will see "Diffuse BSDF" as the default node setting under the *Surface* panel. BSDF stands for "*Bidirectional Scattering Distribution Function*". An elaborate term that basically means what happens to the light when it hits an object. Is it *reflected, absorbed, or transmitted* through the material for transparency or refraction. Diffuse is used exactly like it is in the classic render engine- the light reflected, with no glossiness. Below the surface setting you will see a color swatch, roughness (smooth or rough) and default normal mapping. Clicking on the Diffuse block, more options are displayed.
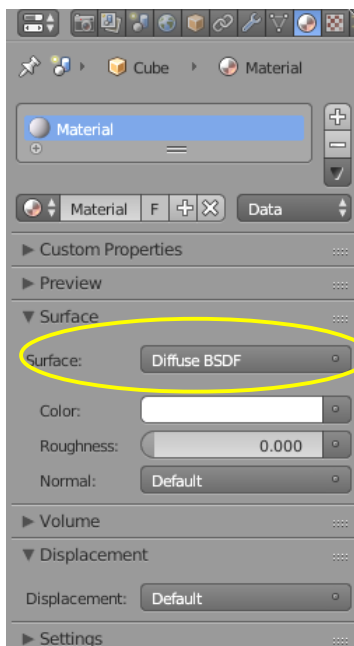
While we we look at more details in the next chapter, we will examine 4 surface options here: Diffuse, Glossy, Emission, and the Mix Shader.
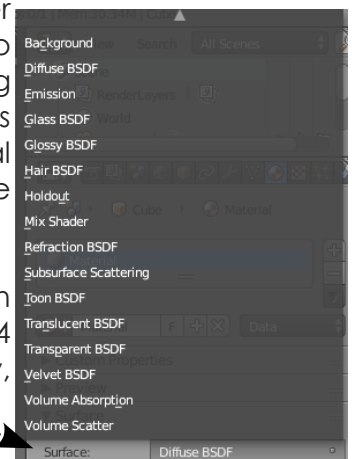
Emission:

Remember we mentioned earlier that we do not use lights in cycles as we normally do in the classic render engine. In real life, we see the light emitting from our lamps. In the classic render engine type lights, we never see the actual lamp. If you create a sphere or pane to represent your light source, you would place an Emission shader on the object and adjust the strength of the emission.

Plane used as a lamp with an Emission surface material.
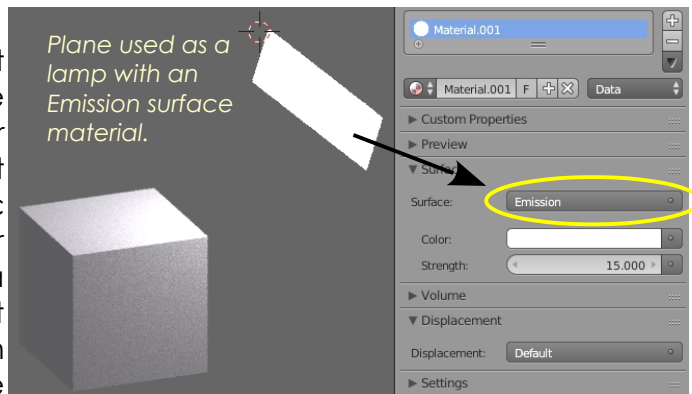
Diffuse:

The cube to the left is using a Diffuse surface material with some roughness applied. The roughness may not be very apparent depending on how many samples you are rending at. Try a higher sample rate for better quality (*discussed on page 4-4*).
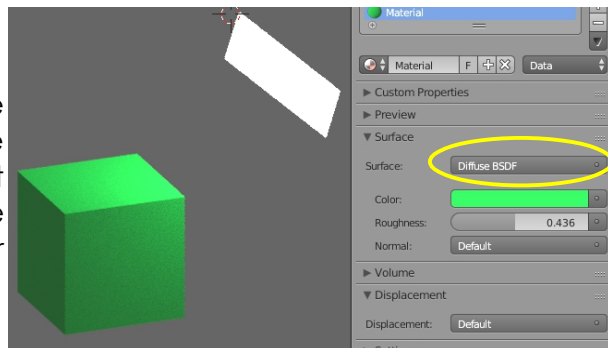
Glossy:

A sphere has been added to the scene on the right with a Glossy surface material added with a blue color. A glossy surface by itself will be a perfect mirror. This is where it is important to mix your surface shaders.
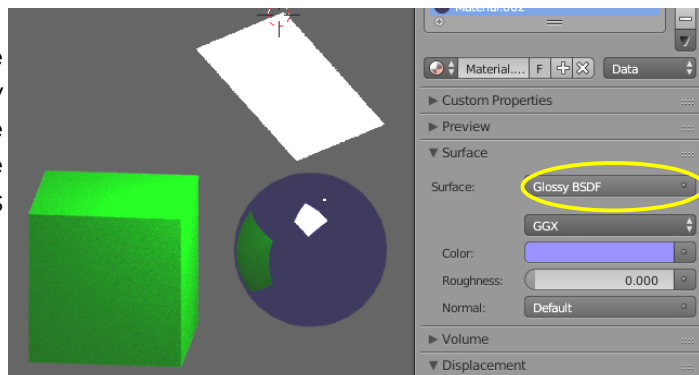
Mix Shader:
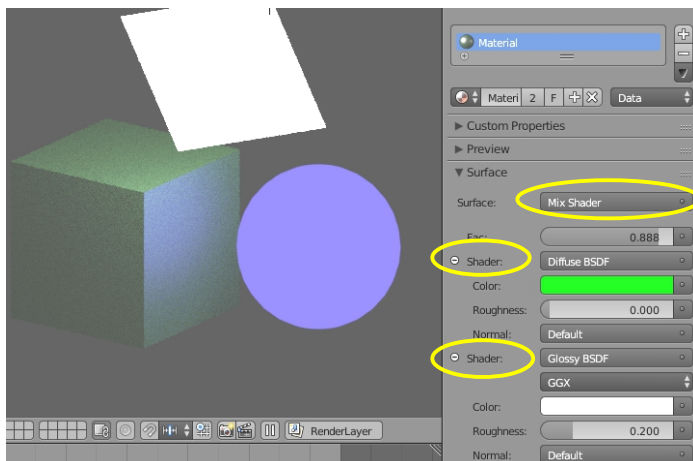
A Mix Shader was selected on the left. You will notice that when a Mix Shader is used, you can now add two more shaders below to combine effects and the balance of the two effects is controlled by the "Fac" slider directly below the Mix Shader (the percentage to use of each). In this example, Diffuse and Glossy shaders were used on the cube, which gives the cube color and reflction. A Mix Shader could also be added to the 2nd slot to mix even more together.
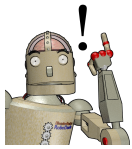
Your Material Setting in Node View:

Now that you have some basic materials set in Cycles, in order to see them in a Node view, change your **3D View** window to the **Node Editor** window (*found at the bottom-left corner of your viewport*).

Here are some of the basic parts of the Node Editor window. More details will be discussed throughout the manual and activities.
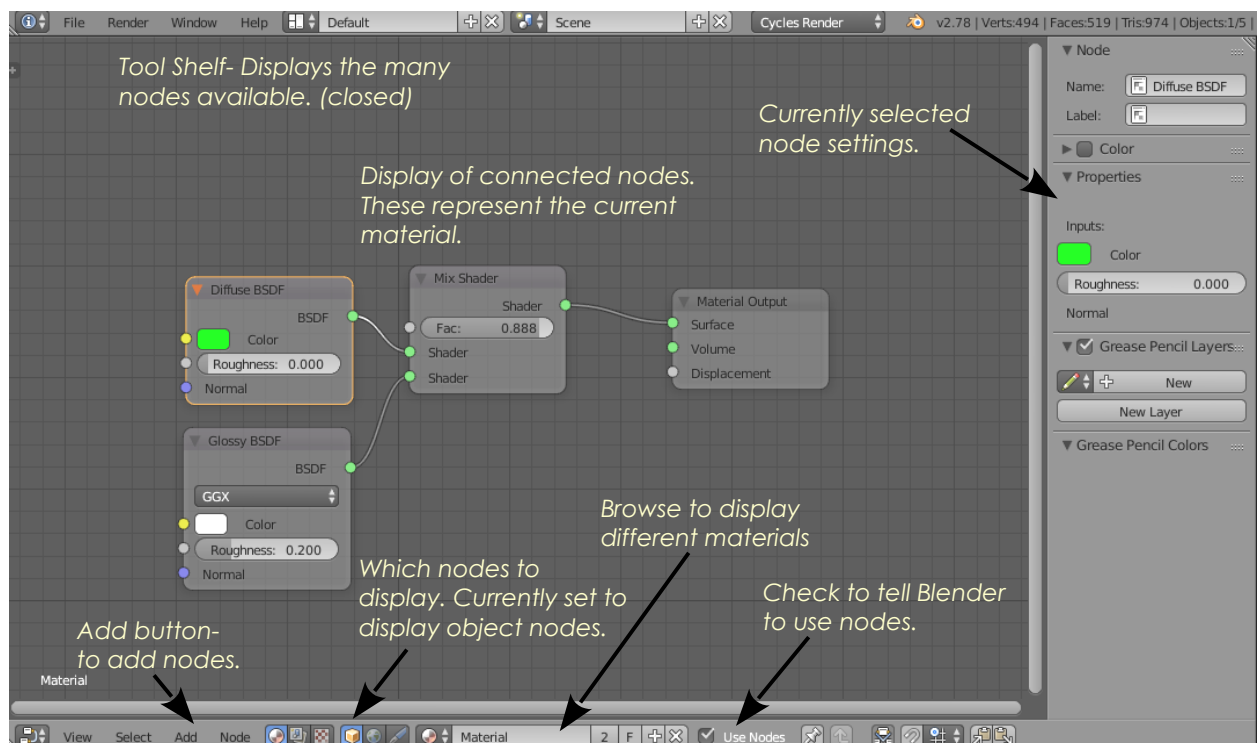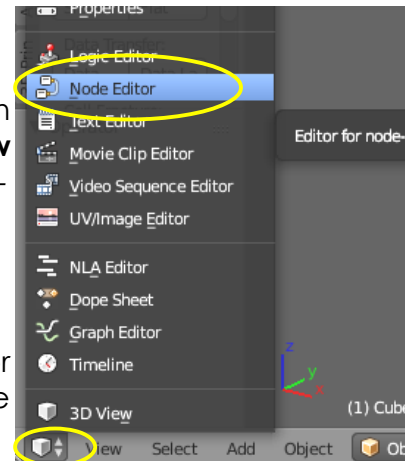
With experience, many people set all of their material properties in the Node Editor window. We will also examine times in future chapters where you can start in the material properties panel and then add additional features in the node editor window.

Working with nodes can be confusing and knowing how to connect them can be more of a challenge. While we will examine the basics of Cycles in this book, the internet is an excellent resource for additional learning.

Tweaking Cycles for Speed & Quality:

So what can you do to speed up renders in Cycles? We already talked about adjusting the sample rates on page 4-4, but what else can you do to speed things up? *Ken Murphy* from Southwest Minnesota State University shared some setting options he uses with his class to speed up the rendering times while giving results similar to the Blender internal render engine. Here are some setting options:
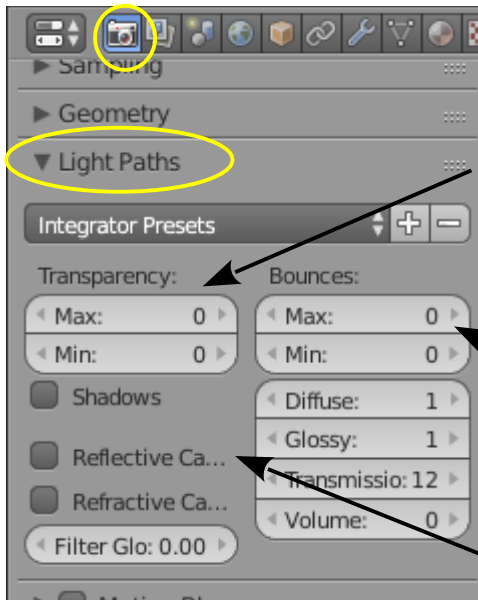
In the **Render** property settings, change the following in the "*Light Paths*" panel:

Transparency: Set the minimum and maximum settings to zero, unless you have transparent objects in your scene. If you need this, try a low number (2-3). The default settings are 8 for both minimum and maximum.

Bounces: Set the minimum and maximum settings to zero, unless you have transparent objects in your scene. If you need this, try a low number (2-3). The default settings are 3 minimum and 12 for maximum.

Uncheck *Shadows* and both *Caustic* settings.

In the **World** property settings, change the following:

Uncheck all option in the "*Ray Visibility*" panel except *Camera*.

In the "*Settings*" panel, uncheck the *Multiple Importance* setting.
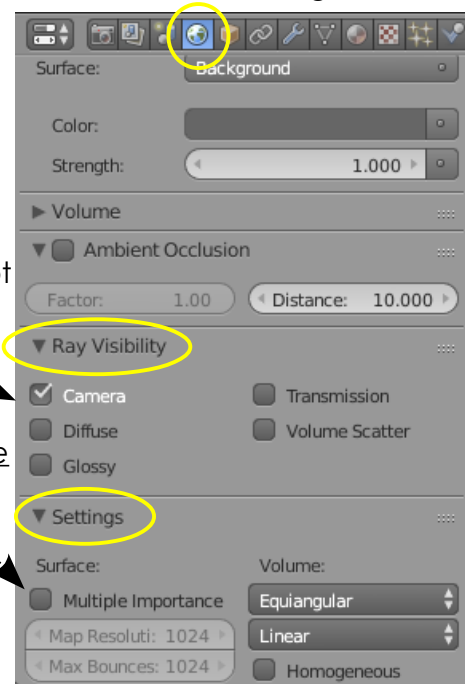
The type of lamps you use will also contribute to your results. While using meshes with an emission shader is ideal in Cycles, a traditional *Hemi* lamp may provide sharp shadows.

Create a simple scene similar to the one below. Place the camera and lamp in good locations to get a render similar to the one shown below. You will start in the classic "Blender Render" engine. Use only one lamp to light your scene. Save this Blender file as "**Test Render 1**", then use the "save as" command to save a second file called **Test Render 2**". You will be experimenting with color and glossiness in this activity.
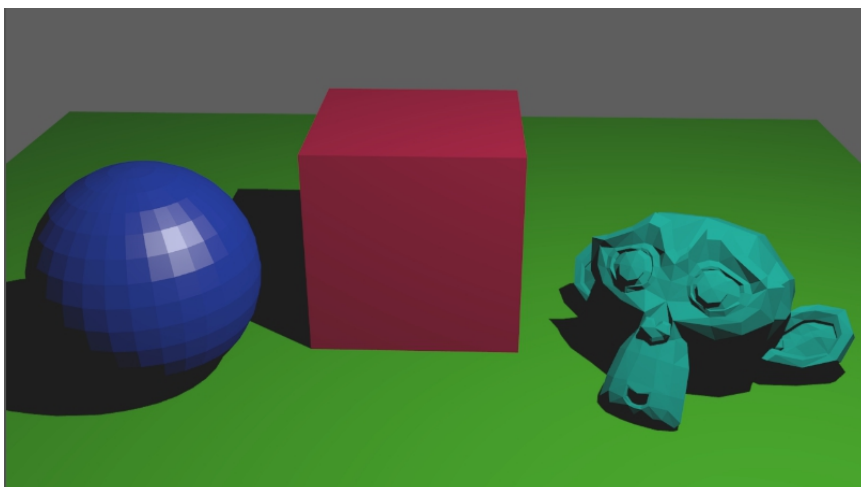
For your "Test Render 1" file using the classic renderer, press "**F12**" to render an image, then immediately press "**F3**" to save a .png image file of your render. Check your saving location and title it "**Test Render 1".png**. (*do not forget the .png at the end*)
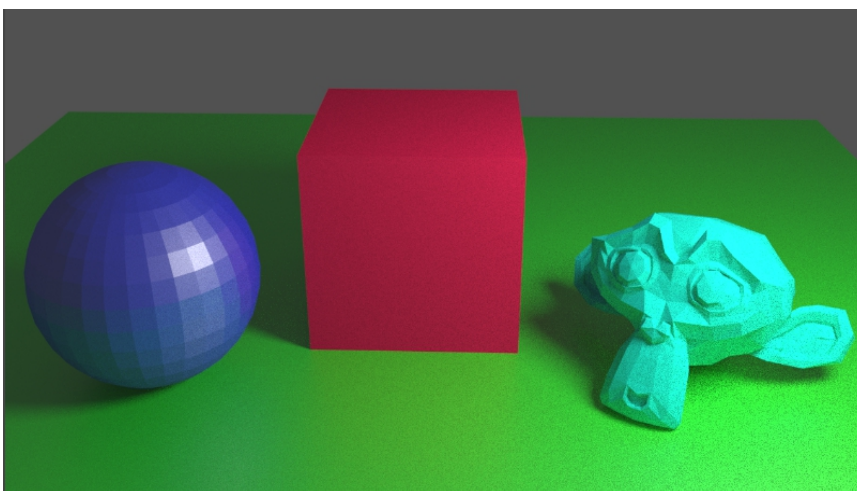
Now open your "Test Render 2" file and switch to the "Cycles Render". Replace the lamp with a UV Sphere and put an "Emission" surface shader on it. Adjust the strength for a good output. Add appropriate material shaders to your other objects in Cycles. Set your render samples as high as your computer will allow for an appropriate render time. Press "**F12**" to render this new image, then press "**F3**" to save the image as "**Test Render 2.png**". (*do not forget the .png at the end*)

Call the instructor when finished

? Chapter 4 Reflection and Wrap-up:

Both render engines have their pros and cons and both can be difficult to master. Compare your two render results and answer the following questions:

1. **Look at the lighting effects in both images. You used one light in each, but have different results. Which one looks more realistic? Why?**

2. **In Cycles, graininess is determined by the number of samples. Why does the image improve with higher samples? Research and explain why.**

3. **Which render engine do you like the best and why?**

4. **You have had a comparison of Blender's two render engines in this chapter, but how does Cycles compare to another program's render engine? Conduct an internet research of another render engine that can be used with other commercial animation programs. Explain your findings.**

As mentioned in the past chapter, materials and textures are what change your model from being gray to brilliant. You can add color, make things glow, become transparent like glass or make them look like brick, grass, stone, metal, fabric, wallpaper, etc. *Remember, we are focusing on the **<u>classic internal renderer</u>** right now.*

Basic Material Settings

You must <u>always</u> add a material before you can add a texture. To add a material, first select the object you want to work with. Then go to the **Materials** panel in the **Properties** window. Then click the "**New**" button *(unless you are working with the initial cube- that has a material on it by default)*. You will see more options open up. The material block is used to change some of the physical properties of the object in how it looks. If you plan on using just straight color and no texture, this is where you set the object's color. The panels can float around so they may not be in this order, but here is what you see with all panels collapsed:

List of all materials linked to object

Browse list of all materials in file

Preview Sample

<u>Diffuse</u>- The actual color of the object settings

<u>Shading</u>- Control self emitting light and ambient lighting effects

<u>Subsurface Scattering</u>- effects for final rendering

<u>Strands</u>- used for hair and grass efects

<u>Shadow</u>- setting related to how the object casts and receives shadows

Add a new material or duplicate the one currently selected

Change the material name here

*How to display the material:
<u>Surface</u>- Normal mode
<u>Wire</u>- Render as a wireframe
<u>Volume</u>- useful for smoke simulations
<u>Halo</u>- Gives verticies a glow*

Different ways to display the sample

<u>Specular</u>- controls the objects glossiness settings

<u>Mirror-Transparency</u>- Raytrace settings will be discussed in a later chapter

<u>Options</u>- a few setting related to the world and rendering

This is just an overview of the basic material panels. On the next page, we will highlight some of the important panels we will be using at this time.
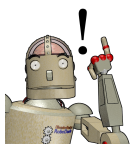
<u>RoboDude Asks:</u> How can I see all the panels on the screen?
Remember panels can be collapsed and opened as needed to streamline your view. You can also scroll with the mouse wheel!

Chapter 5- Materials & Textures

Material Panels:

Here are some of the basic material panels and settings. Some of this will be a review from the past chapter:

Diffuse:

Diffuse is actually the color that is given off by the object. If you want the object to be red, set it here. You will also see settings for the way the material is calculated (default-Lambert) and the intensity slider. The Ramp button will allow diversity of color.

By clicking on the color sample in diffuse (or in any other block dealing with a color), the color wheel will pop up. You can set the color using the wheel and light/dark slider, setting in manually using RGB, HSV, or Hex numbers. You'll also see an eyedropper for picking a color elsewhere.

Specular:

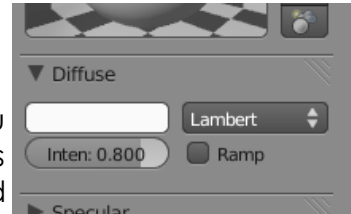Specular settings control the *glossiness* of the object (is it flat or shiny?) You will see a color sample, calculation model and ramp as in Diffuse. The color sample indicates the color reflected back (usually kept white). Intensity controls the amount of glossiness while the hardness slider controls the hardness and softness of the glow. Check the sample as you change these settings to see how it changes appearance.

Shading:

If you want something to glow, even in low light, adjust the *Emit* slider. *Ambient* light allows the object to also react as if indirect light were hitting it. There are also a few other shading settings here as well.
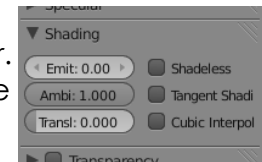
Transparency:

For now, we will only look at using the "*Z Transparency*" option (Raytrace has it's own chapter). After checking the *Transparency* box and "*Z Transparency*" selected, you can control how transparent an object is using the *Alpha* slider.
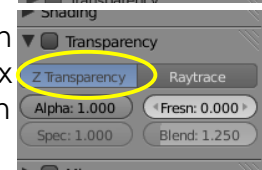
SubSurface Scattering:

Is used to improve rendering for materials where light enters the material and leaves through another point (*like skin*).

Strands:

Strands are used to represent hair or grass when used with particle systems (discussed in a later chapter). With strand settings, you can control the root and tip width of the strand.
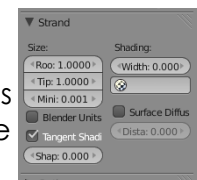
Shadow:

There are time when you do not want an object to be able to cast a shadow and times when it doesn't receive shadows properly from objects with transparent materials or ray-tracing features. Those options are controlled in this panel.
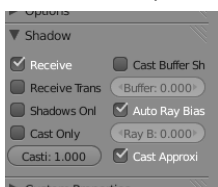
Transparency Using Z-Transparency:

The easiest way to make something transparent in Blender while still maintaining a fast render speed is to use the **Z-Transparency** feature and controlling the **Alpha** setting. In the *Material* panel, turn on *Transparency* and select *Z-Transparency*, then slide the **Alpha** control down. Press the F12 button to render an image. If you need features like distortion (refraction), then you will need to use **Raytrace Transparent.** Refraction is the effect you get like looking through a magnifying glass or a crystal. Avoid using Ray features at this time. They are discussed in a later chapter.
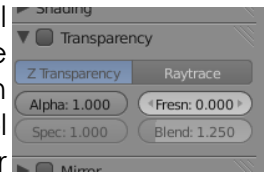
Z-Transparent material

Halo Settings

By using Halos on objects, you are basically only making the vertices visible when rendered. Halo effects give you a star-like image on every vertex. **Sometimes, it adds a nice effect to take a plane and delete all vertices except for one**. This one vertex can be used like a shooting star or a "Tinkerbell" effect in an animation. Tie it 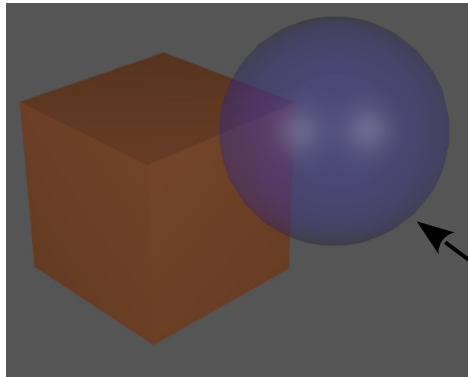to a particle effect (discussed in a later chapter) and you can produce some interesting results. When you press the "*Halo*" button in the material panel, here are your options:

Turn ON Halo

Halo glow only

Rings only

Lines only
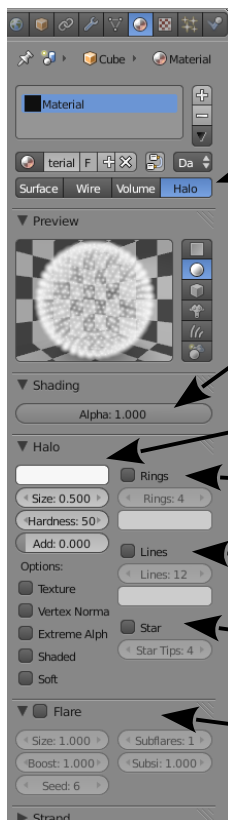
Halo Transparency

Star only

Halo Color and Hardness

Check to add rings, count and color

Check to add lines, count and color

Rings, Lines and Star

Check to add stars and tips

Flare adds additional rings and effects
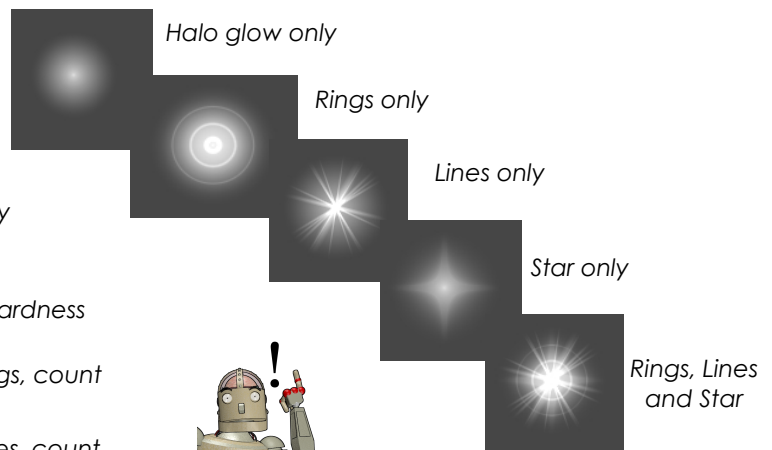
Halos can also be animated to give a variety of effects. Animation basics are discussed in a later chapter. There are also other options with halos not discussed. Halos are also used to control the size and appearance of particles in smoke and fire effects. These will also be discussed in a later chapter. Feel free to experiment!

Basic Textures Settings

After you create a material and would like to add some kind of texture to the object (i.e. brick, carpet, wood grain, etc), you then click on the **Texture** button beside the Material button. After you click the "***New***" button, you have some choices in the texture buttons. First, you need to decide if you wish to use one of Blender's preloaded texture generators or provide your own image as a texture. Blender is capable of using almost any image file type whether created in a paint program or is a photographic image. JPEG images are most common. Blender can even place a movie on an object as a material! This is a good effect if you want to add animation *within* your animation.

Here's what you see in the texture panel:

Texture Channels:
You can add multiple textures to an object. For example, lets say you want a marble texture on an object, but also want to add a roughness to the surface. You would add a texture for both effects.

Texture Name:
Like materials, it's a good idea to name your textures. In this area, you can also add "+" and delete"X"" materials.

Texture Type:
Choose between built-in texture generators for wood, marble, stucci, etc or select an image or movie.
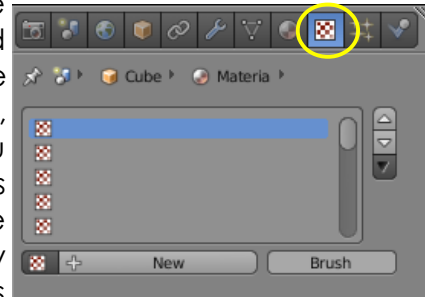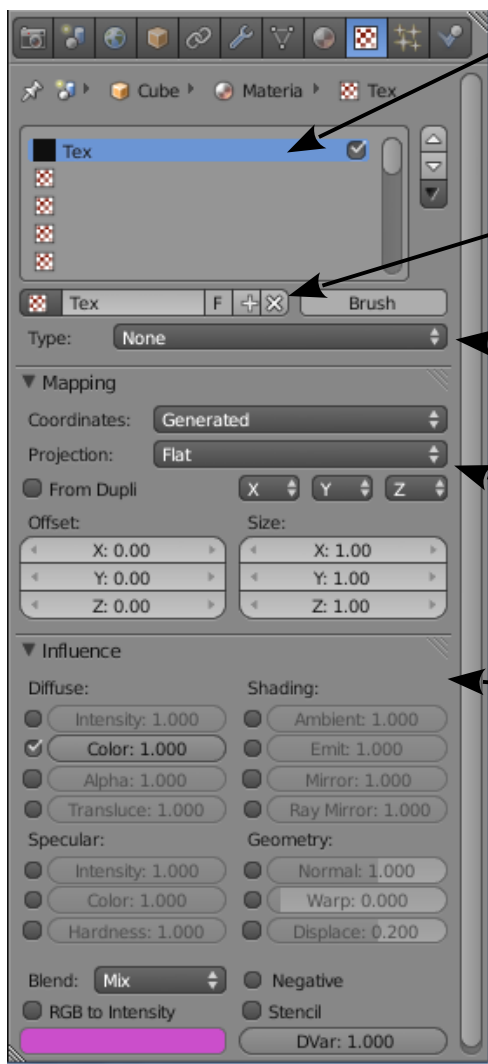
Mapping:
Setting that control how the texture is mapped onto the object. Also control the size and offset of the texture on the object. **Mapping used to always be set to "Generated", but is now set to "UV" by default. Change it to "Generated".**

Influence:
Settings that control appearance such as brightness, transparency, glossiness and roughness. S are also effected by the Material setting. Materials and textures work together. Many textures use a secondary color in their generation. That is also controlled in this panel.
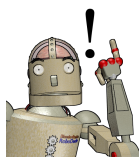
RoboDude Says:
You can't add a texture unless you've already added a material. Material and Texture properties work together!

Blender's Built-In Textures:

Let's say you want to use one of Blender's built-in textures (*under the "Type" option*). For now, we just want to look at **Clouds, Stucci, Magic, Marble and Wood**. These can produce some interesting effects with a little practice. When you select one, setting options will open for that effect. Each texture has different tools available to work with, but some similarities are present in most:

Most of Blender's texture options deal with turbulence and noise (randomness of the pattern) The wood texture also has some features dealing with the pattern of the wood grain (bands and rings). After you place the texture, you still need to go back to the Materials Buttons to fine tune the look on your object. The *Stucci* texture involves a little more work and will be discussed later in this chapter.

Many textures have a *Noise Basis* for different texture effects.
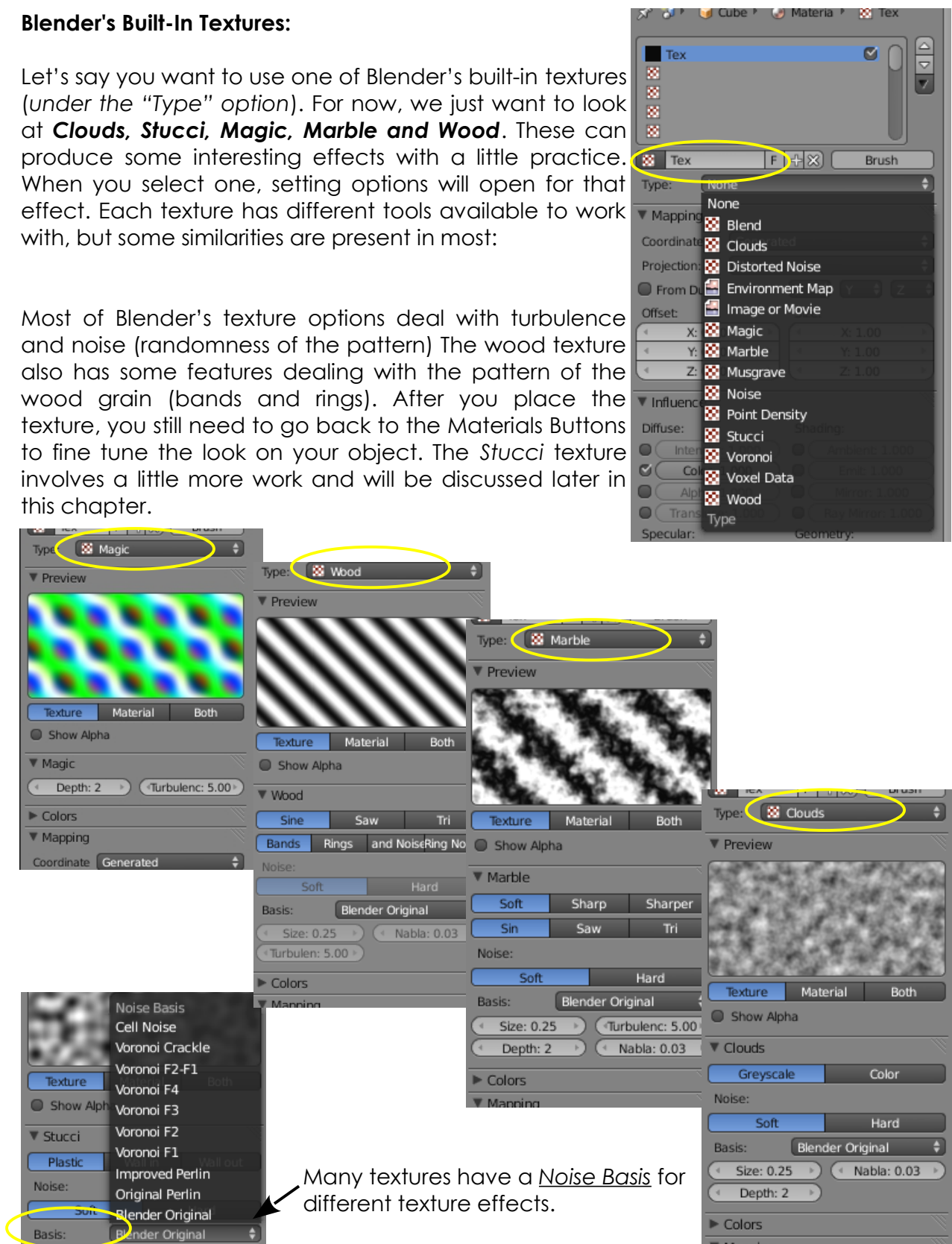
Chapter 5- Materials & Textures

For an example of using textures, we will apply a wood texture to a cube. We'll start with a basic cube that has a material applied to it. Since wood is usually various shades of brown, we'll make the *Diffuse* color brown. We'll also take *Specular Intensity* down a bit.
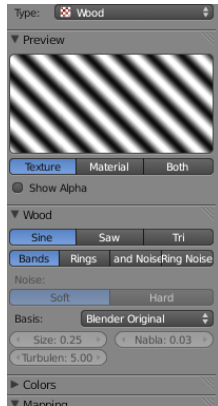
We'll now go over to the texture buttons and add a new texture. Make the texture type "*Wood*". In the wood texture panel you will see some different ways to represent the wood grain. "*Sine-Saw-Tri*" will give you a different stripe while "*Bands-Rings-Band Noise-Ring Noise*" will give you a different pattern. For my example, I will select "Ring Noise" and hit "F12" to render a picture. **For these exercises, remember to switch "UV" to "Generated" in the "Mapping" Panel!**

If you look at your render, you should see your wood grain, but you have a secondary color that needs to be corrected! To fix this, scroll down through your texture panels to find the color swatch to change this to a better color. I will choose a darker brown.
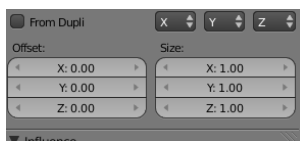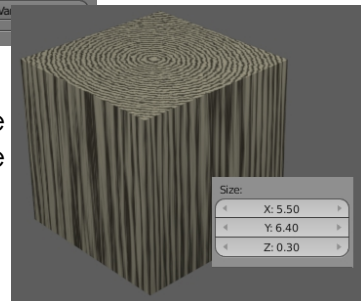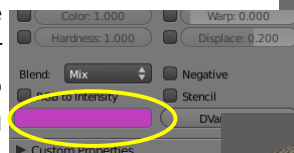
You can also adjust the *Size (X,Y,Z)* of the texture and the *Noise Basis* for more effects. Feel free to experiment with the various other settings.
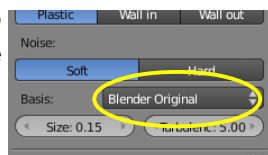
The Stucci Texture:
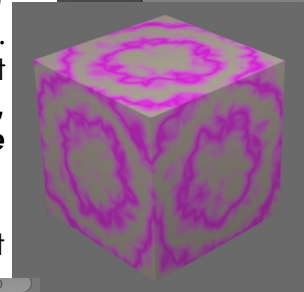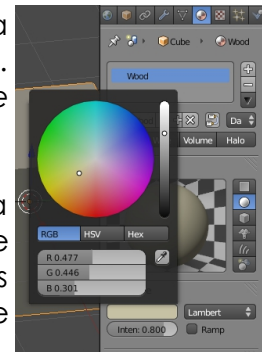
The *Stucci* texture provides interesting effect on the surface of your object. In the *Texture Buttons*, select it as you do for any of the other texture generators and adjust the settings. In the Stucci panel, I will adjust the size to 0.15. Next, go down to the *Influence* panel and turn on "*Nor*" (*for Normal*) under *Geometry* for normal. Adjusting the **"Normal"** slider to adjust the amount of the effect. Play with the setting to get a bumpy effect. Turning the size setting way down can also give you a grainy effect.

Below are some samples of different Noise Basis patterns.
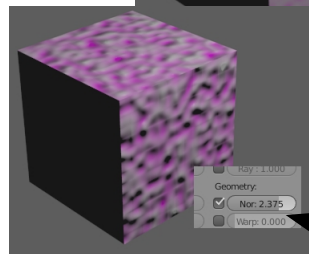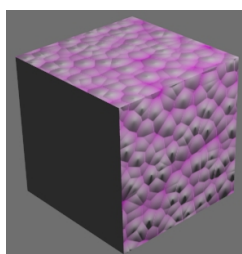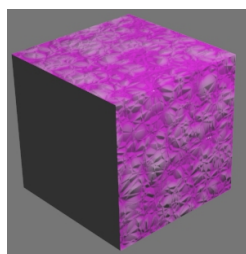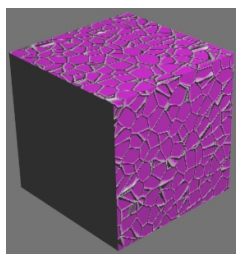
Normal Off

Normal On

Using Images and Movies as Textures

The basic texture generators are nice, but not complete. Most of the time you need to place textures like grass, brick, metal, fabrics and such into your model. **Anything that can be saved as a JPEG image can be used as a texture in Blender.** Most other image type files can be used as well (png, targa, TIFF, bmp). If you want to put a picture of your face on an object- you can! Movie files can also be placed on an object as a material. To use a JPEG as a texture, add a *Material* as before, go to the *Texture* buttons and select the "***Image or Movie***" option under "*Type*". When you select this, here is what you see for options:
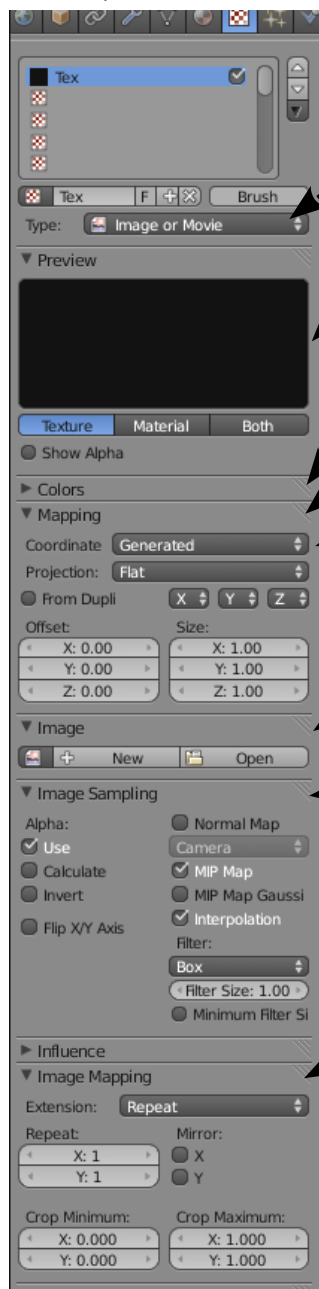
Texture Type:
Changed to "Image or Movie"

Preview Window:
Can be set to display Texture or Material or Both

Colors Panel:
An image can be adjusted if colors are not quite what you want (i.e. a wood grain that you may want more red in it)

Mapping Panel:
Textures can be projected <u>Flat, Cube, Tube, or Sphere</u> onto an object. Important block! Here, you can also adjust the offset and size of an image on your object.

Coordinate Mapping:
New default settings have this set to **UV**, which will be discussed in a later chapter. Change this to "***Generated***" for these lessons.

Image Panel:
This is actually where you open the image or movie you with to use for your texture. If you don't see thumbnails of your images, you can change the window's viewing type (see page 1-4 for details).

Image Sampling Panel:
Make adjustments to your image such as Alpha (transparent images). For example, you have a tree image made in a graphics program with a transparent background. Set alpha here to remove that background.

Image Mapping Panel:
If you would like to have the texture repeat (i.e. a brick pattern where you need to use the image several times on a surface), set it here. You also have mirror options in case the image you're using doesn't appear seamless.

*Remember to switch "**UV**" to "**Generated**" in the "Mapping" Panel! UV Mapping will be discussed in a future chapter.*

Chapter 5- Materials & Textures

For an example of using images, here is a cube and sphere rendered using a brick image. You will notice that, by default, the image is mapped onto the top and stretched down the sides of the object. This is called "*Flat*" mapping. This can be adjusted in the "*Mapping*" panel. Your other options are shown below:

Mapped Flat
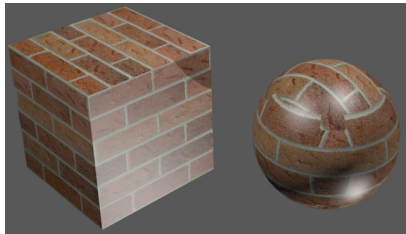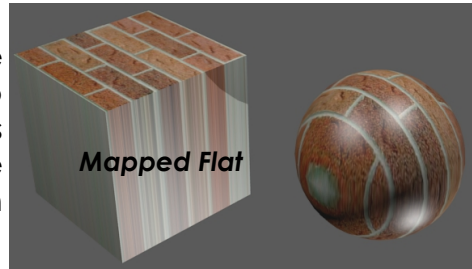
Mapped Cube
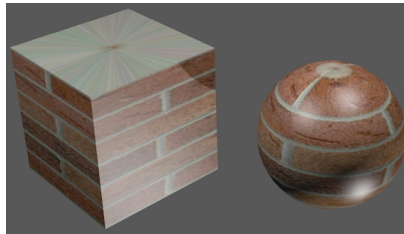
Mapped Tube
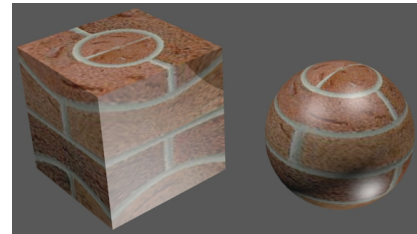
Mapped Sphere
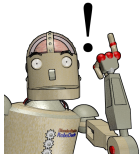
RoboDude Asks: *I've worked with all these settings, but the texture still won't map correctly- what's wrong?*
Textures can be affected by rotation and scaling of objects. Try pressing Ctrl-"A" to reset scale and rotation.

Let's say I want to use the "*Cube*" mapping, but the bricks are too large. I can control this in the "*Image Mapping*" panel under the "Repeat" option. The image I used tiles well, but if it does not you can press the *Mirror- X and Y* buttons.
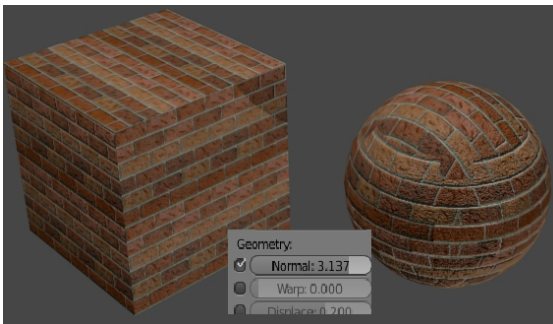
Remember that the *Material* and *Texture* panels work together. The bricks look good, but a bit too glossy and flat. You can make adjustments to Specular in Materials (glossiness) and add a "*Normal*" to the brick texture in the *Texture* panel under the "*Influence*" panel. This will simulate depth and add a nice effect to the brick.
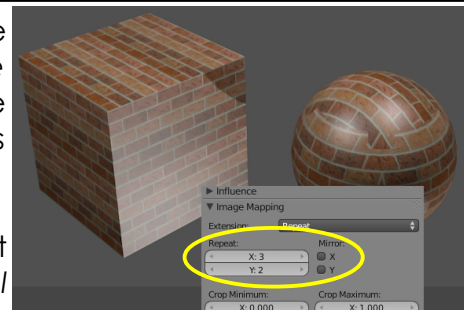
Movies as Textures:

You load a movie just as you would load an image, except that you have a few other options. You can control which frames of the movie to use, when it starts (offset) and if the movie cycles through your animation. This can be a great option for animated backgrounds, and motion on objects. Remember that all movie formats may not be supported.
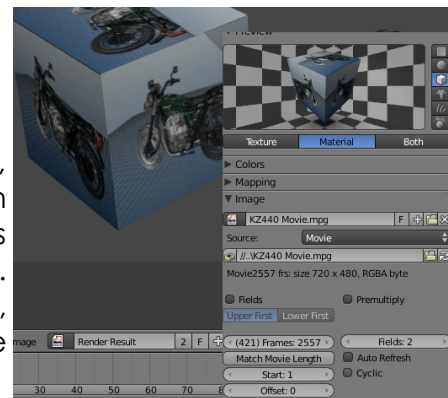
Displacement Mapping

Displacement Mapping is using a texture effect to deform the mesh. Basically, you can make a cube, sphere, etc. look wrinkled or deformed without having to move vertices

around to do it. To start, create a cube or sphere. If you start with a cube, go into **Edit Mode** (tab) and select **all vertices**, press the **Subdivide** button a few times in the **Tool Shelf**. Displacement works off of vertices so if you don't have it subdivided a few times, you won't get a good effect. Next, put a material and a texture on the object. I used the *Cloud* texture in Blender. Here's what we have by pressing F12:
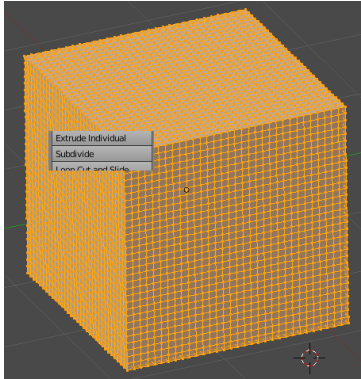
Nothing that we haven't already experienced in this chapter so far. Now,

go to the "**Influence**" panel and find the "**Displacement**" button to turn on Displacement and adjust the slider. Re-render (F12). Displacement basically works by pushing vertices with the varying colors in the texture. This is also controllable.
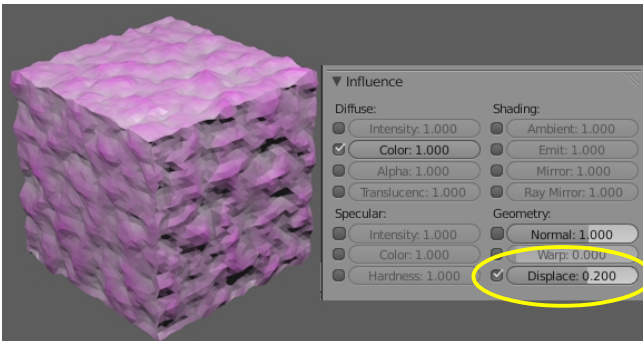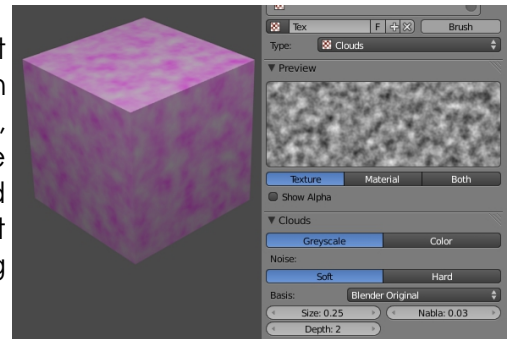
For our next test, I will create a simple image in a graphics program using only simple gray, white and black shapes. Gray is considered the base color.
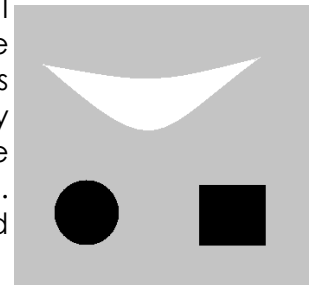
Here are the effects of the image on the object mapped with the **Cube** wrap. Notice that the white shape was pushed out while the black shapes went in. The quality of the cuts and extrudes is determined by the subdivision (vertices) on the mesh.
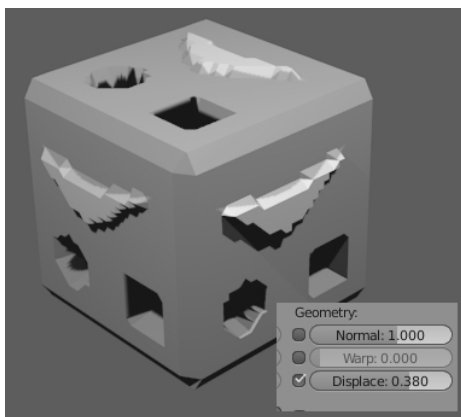
To the right, the shape has been subdivided a few more times for a better edge. While *Normal* gives the illusion of depth, *Displacement* will actually deform, but it makes the shape more complicated and slower to render.
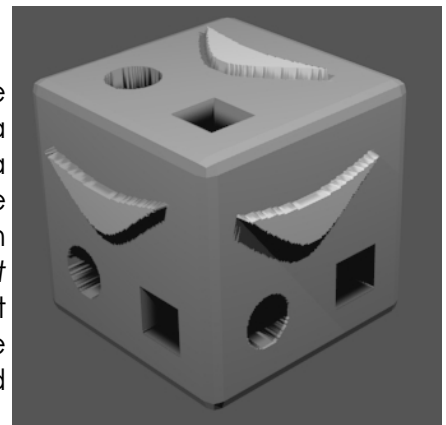
Materials & Textures in Cycles

We will now discuss Cycles materials and textures in more detail. Switch your render engine from "Blender Render" to "Cycles Render". Remember to set you processor and samples as discussed in the previous chapter.

Basic Material Settings in Cycles:

We have already discussed the *Diffuse*, *Glossy*, *Emission*, and *Mix Shader* nodes in the last chapter. Surface shaders can be applied in the Materials properties panel, but can also be applied in the Node Editor window through the Tool Shelf or from the "Add" button at the bottom of the window. Here are some of the other shaders:
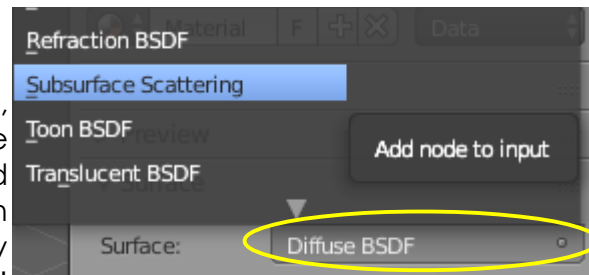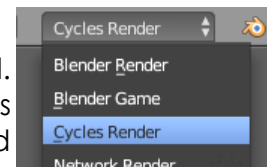
Ambient Occlusion- can be used to add darker shading to recessed areas and corners.

Anisotropic- can act like the glossy shader, but will distort the reflection in a direction.

Diffuse- just like diffuse in the classic render engine, the color for the object with no reflection at all, like flat paint.

Emission- used to light your scene. Can be mixed wit other shaders.

Glass- makes an object look like glass. You can control distortion using the IOR (*index of refraction*) setting.

Glossy- add a chrome or mirror look or mixed with other shaders to control the amount of gloss.

Hair- Used with particle strands for hair or a fur look.

Holdout- create holes in your render, good for creating overlays.

Mix Shader- used to combine shaders for blended effects.

Refraction- acts like glass, but distortion only and no reflection.

Subsurface Scattering- scatters light beneath the surface, like in a wax candle.

Toon- used to simulate cartoon-type material shading.

Translucent- lets light pass trough it, like paper or stained glass.

Transparent- completely transparent or tinted or combined.

Velvet- great for cloth. Gives a velvet effect.

Volume Absorption- affects the volume, not the surface. Gets darker the deeper it goes.

Volume Scatter- scatters the light that passes through it. Good for clouds and smoke.
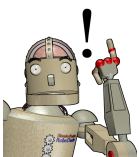
> ### *RoboDude Says:*
> *The Blender Guru website has a nice page dedicated to the different Cyles shaders and can be found here:*
> **http://www.blenderguru.com/articles/cycles-shader-encyclopedia/**

Basic Texture Settings in Cycles:

In the classic render engine, textures are applied after materials in the properties panel. *Cycles does not use the textures panel at all.* Textures in Cycles are applied to a Diffuse shader node, with other nodes being used for more control. Like textures in the classic render engine, there are several built-in texture generators in Cycles.

To start using textures, apply a Diffuse shader to an object, then click on the small button on the "Color" setting option. When you click the button, you will see a column of texture options, like the image displayed to the left.
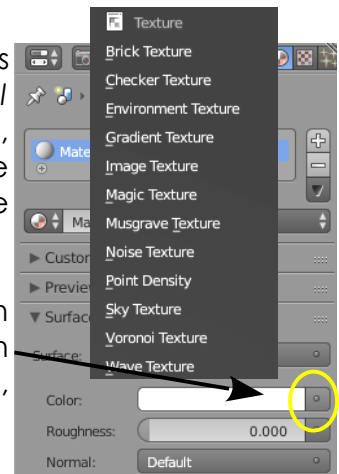
Like the material shaders, texture shaders can be accessed from the Node Editor window Tool Shelf as well. Here are the basic texture nodes available:

Brick- can be used to simulate a brick texture on an object. Settings for colors, size, motor joints, etc.
Checker- creates a checkerboard effect on your object.
Environment- used to project background images in the world.
Gradient- used to generate a gradient fade across your object.
Image- uses an image file to project on your object.
Magic- creates a colorful "tie died" look.
Musgrave- can create a very "organic" pattern, like *stucci* in the classic render engine.
Noise- a random TV-like static pattern. Different for every frame.
Point Density- Used for particles and volume.
Sky- used in the world setting to generate sky effect.
Voronoi- cells, skin, hammered metal look.
Wave- takes the place of wood and marble textures.

Create a simple scene and experiment with the various texture nodes and settings to get a feel for how they work. Some of these nodes are designed to work with the world, or background, settings and will be discussed in more detail in the world chapter.

So How Real Do You Want It To Look?

So far, we have only been applying materials and textures in the materials property panel, but the strength of Cycles is in the *Nodes Editor* window. Understanding how to connect the various nodes and which ones to use can be a difficult learning process that few people have mastered. 3D modelers are always trying different things and posting their results on the internet to share with others, so make use of that wealth of knowledge. 3D modeling, animation and texturing is a process in the study of nature. How realistic do you want your model to look? Many people have gone to great lengths to use material shading nodes to achieve realistic effects. The following examples will help you in the journey into understanding Cycles shading.

Basic Color with Gloss:
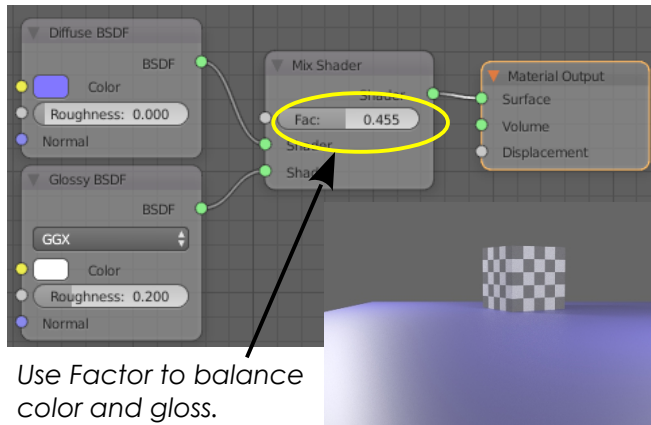
Use Factor to balance color and gloss.

The next several examples will work with various shader nodes for the plane. This scene is using simple *Mix, Diffuse, and Glossy* nodes on the plane. You will notice that nodes have multiple input (left side) and output (right side) connection points. Nodes can also be collapsed by clicking the small triangle in the top of the block. Nodes are connected and disconnected by dragging lines to and from connection points. You will notice some of the same terms used in the materials property panel, like *Roughness* to control surface smoothness, *Factor* for the amount and balance of the nodes, and *Color* to control the color settings. You will also notice that other nodes can be connected to many of these settings to control them.

Basic Image and Gloss with Roughness:

While most of these settings can be handles in the materials properties panel, some need to added in the Node Editor.
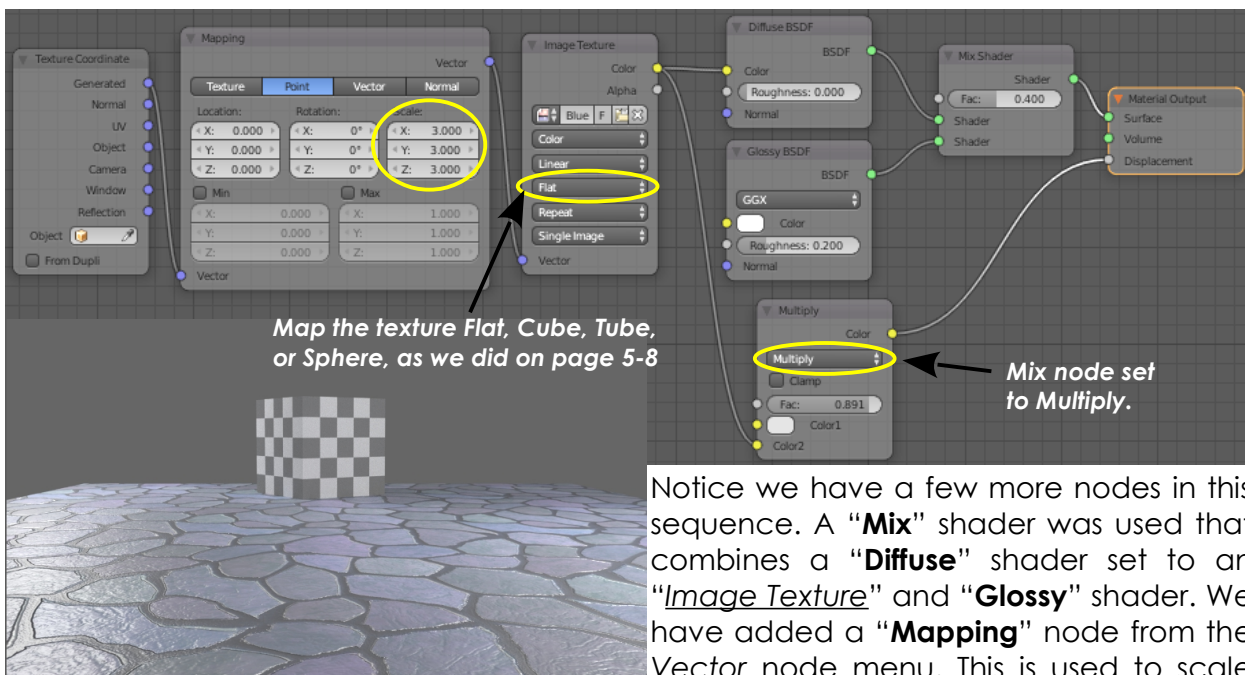
Map the texture Flat, Cube, Tube, or Sphere, as we did on page 5-8

Mix node set to Multiply.

Notice we have a few more nodes in this sequence. A "**Mix**" shader was used that combines a "**Diffuse**" shader set to an "*Image Texture*" and "**Glossy**" shader. We have added a "**Mapping**" node from the *Vector* node menu. This is used to scale the image we used to make it look like there are more stones. The "**Texture Coordinate**" node (from the *Input* node menu) is set to "*Generated*", like we have used before, and is tied to the "Mapping" vector input. In order to make the stones look like they are three-dimensional with mortar joints, we have added a "**MixRGB**" node from the Color node menu and set it to "*Multiply*", setting the factor to a higher number to adjust the depth appearance. This node is tied between "Image Texture" and "Material Output" nodes on the Displacement connection. Displacement simulates texture depth.

Basic Glass:

While you can use just the "**Glass**" shader alone, It often works better when mixed with a "**Transparent**" shader. The *IOR* (index of refraction for distortion), *Color*, and the mix *Factor* can all be adjusted for the desired look.
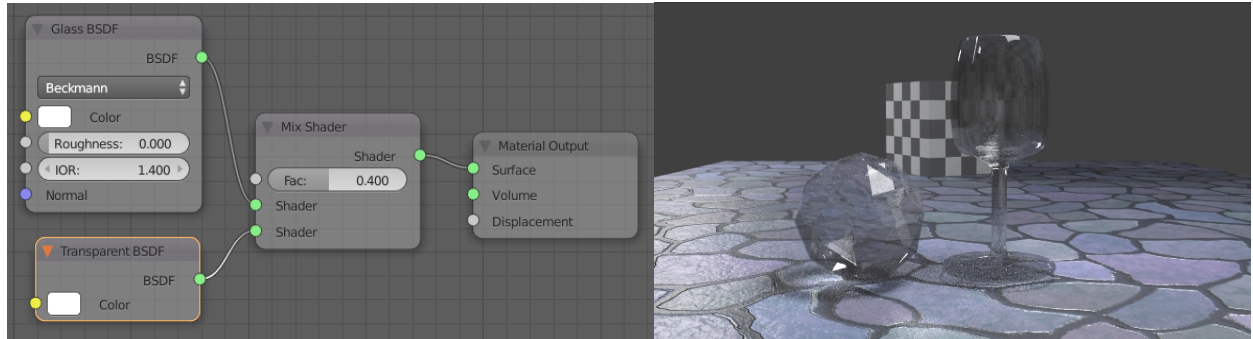
Texture Displacement and Polished Metal:

This example demonstrates two shading examples. The monkey on the left uses a wood image texture, mapped flat using generated texture coordinates on the vector and using displacement. The monkey on the right uses a simple mix shader. The Glossy node color was set to a *light yellow* color from white to better complement the Diffuse color. Notice the reflection on the yellow monkey from the floor.
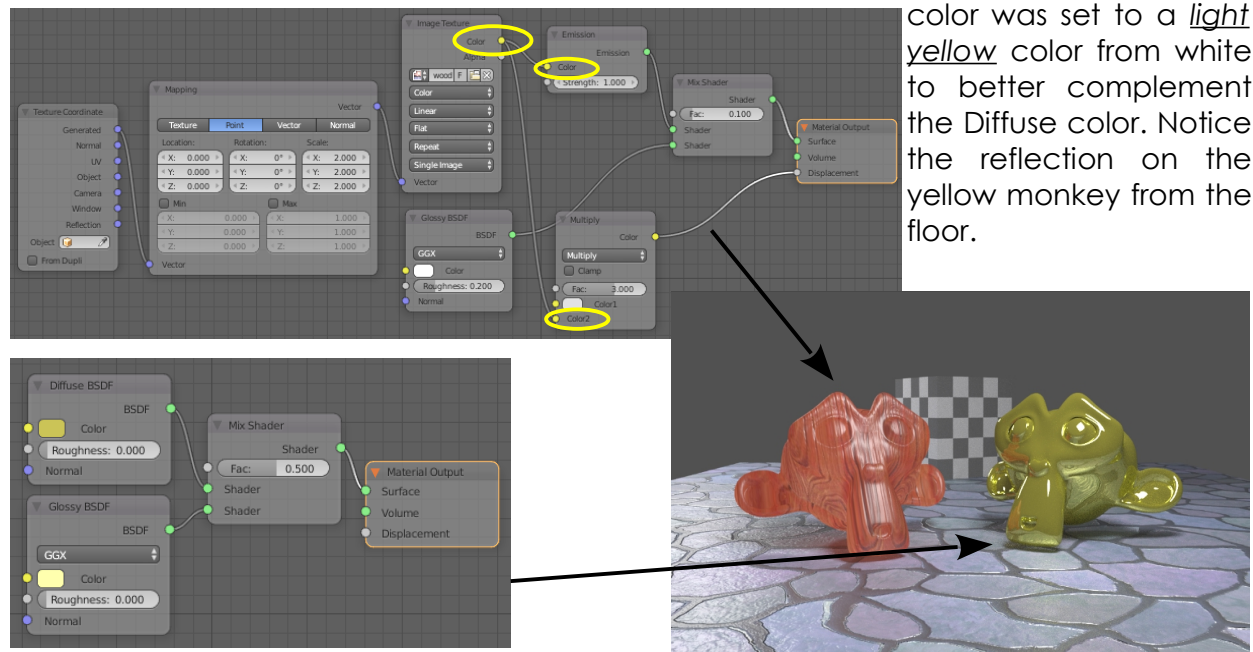
What do the different node connection points mean?
Even the people most experienced with Cycles on the web seem to ask this question from time-to-time. Nodes are basically a data processing pipeline with inputs and outputs. Experimenting with them is the best way to learn them. Some of the term you need to know are:

Image- The basic connections that pass the image results through the block.
Factor- Controls the amount of influence in the node. Mix nodes balance the 2 inputs.
Vector- Basically determine how your texture will be mapped on your object.
Displacement- Like "normal" in Blender internal renderer. Simulates texture depth.
BSDF and Shader- Connect like the Image connections to blend and mix results.
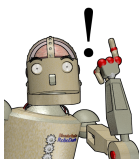
Chapter 5- Materials & Textures

Stone Materials:

Creating stone textures in Cycles can also be a challenge with very realistic results possible. Here are some basic setup options to get you started:

The monkey on the left uses a *Noise* texture and a *Voronoi* texture, set to Cells to create a rough, cracked material. Both are run through *Color Ramps* (found in the Converter nodes menu) to control the color effect. We use 2 *Mix* nodes (from the Color nodes menu) with one set to "Value".
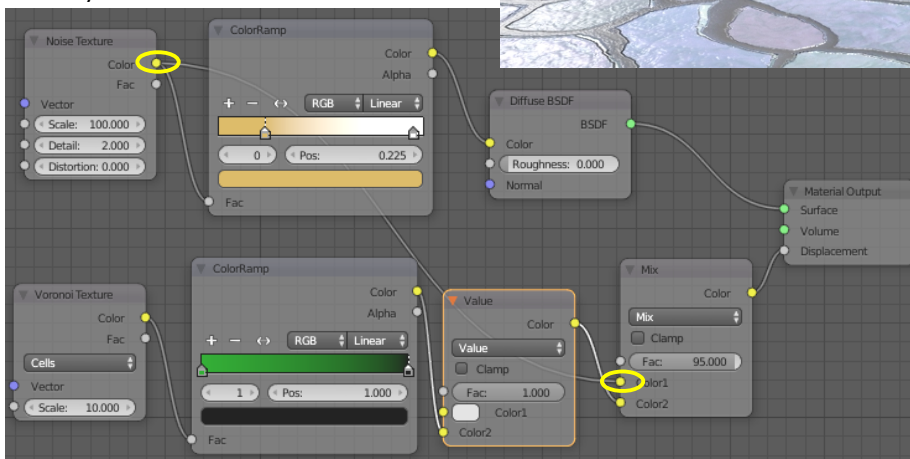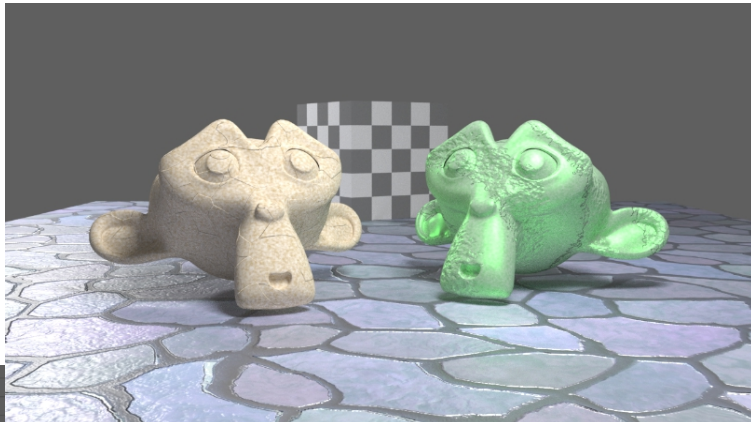
It is finally mixed with the Noise texture and connect to the Displacement output. Adjust all values to get the effect your desire.
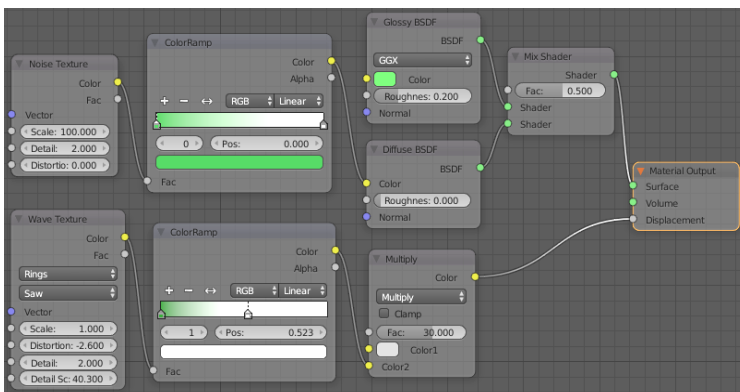
The monkey on the right also uses a *Noise* texture with a *Color Ramp* node that is mixed with a *Glossy* shader. The *Wave* texture and *Color Ramp* are connected to an *Mix* node set to Multiply to control the Displacement roughness. Experiment with the wave settings to get the effect you desire.

Simple Brushed Aluminum:

The Anisotropic shader can simulate a texture with distortion set to a direction.
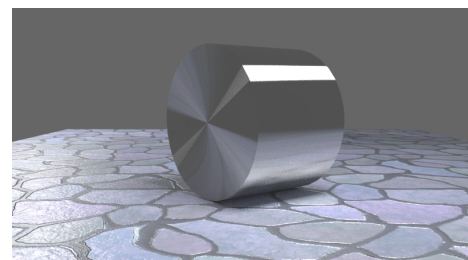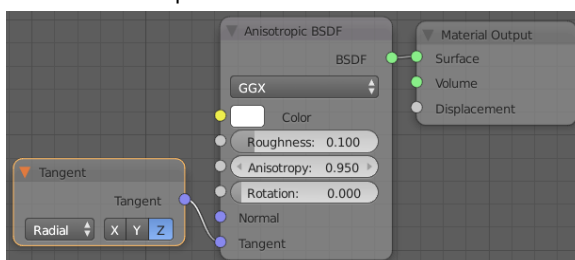
In this activity, we will be using the classic render engine to put put materials and textures on the lighthouse and scene. We will also introduce you to the ocean simulation modifier to create some realistic looking rough water for our stormy scene.

Start by opening up your <u>Landscape Scene</u>. Make sure you are in the "**Blender Render**" Select the plane(right-click) and go to the "**Materials**" panel. Add a new material.
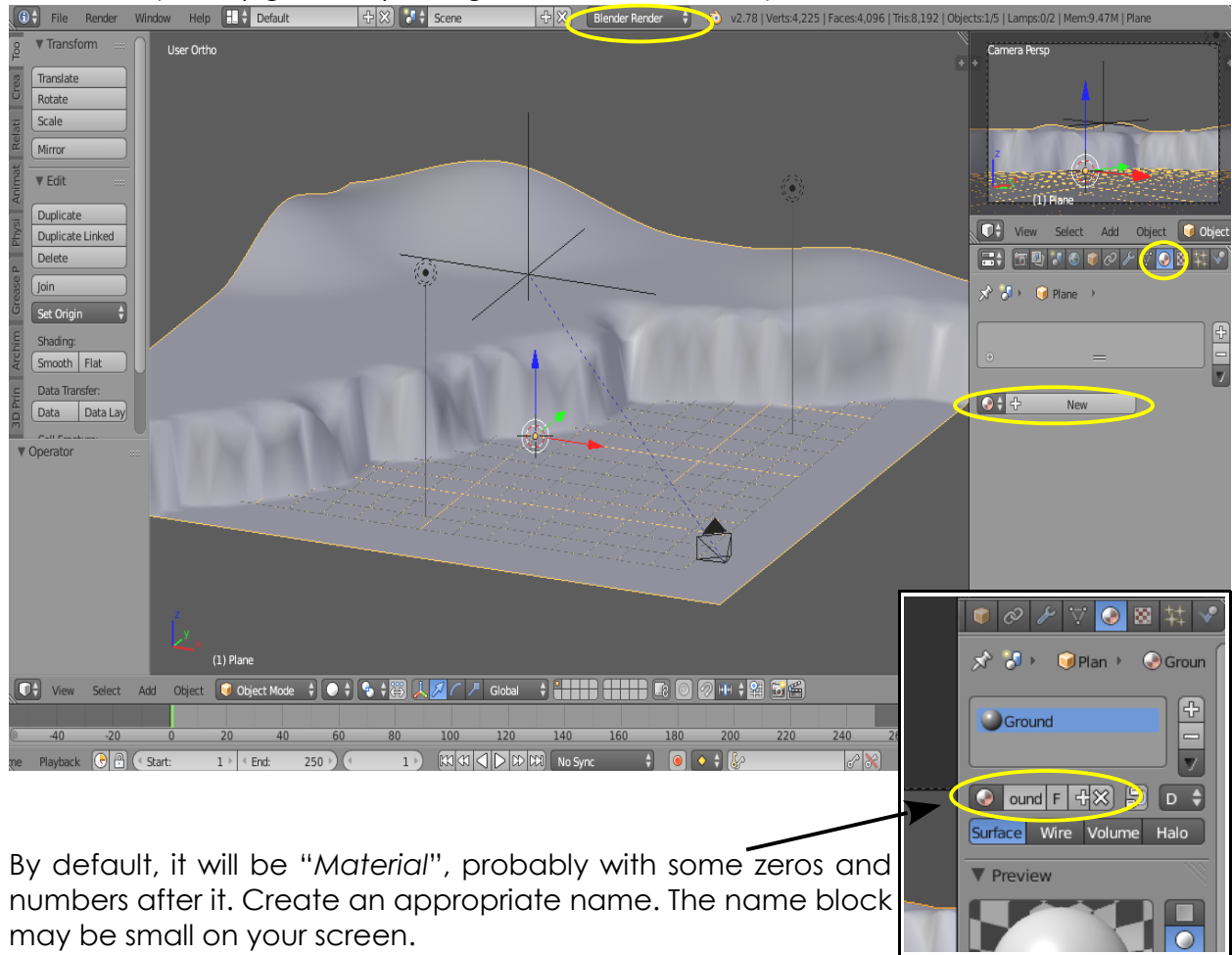
By default, it will be "*Material*", probably with some zeros and numbers after it. Create an appropriate name. The name block may be small on your screen.
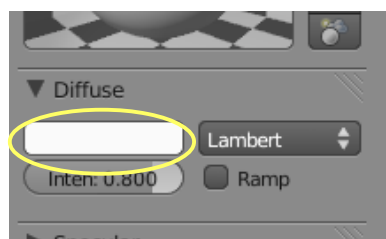
Under "<u>Diffuse</u>", click on the color swatch to open the <u>Color Wheel</u> and select a shade of green. You can select a shade of green 2 ways- by using the RGB sliders at the bottom of the panel or by moving the dot in the wheel, then adjusting the brightness with the white-to-black slider on the side. I know this doesn't look too realistic at this point, but we will apply a nice soil/grass texture in the next exercise. For now, you're just working with material basics.
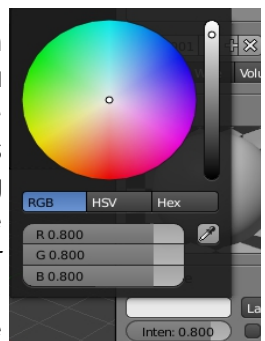
PERFORMANCE TASKS
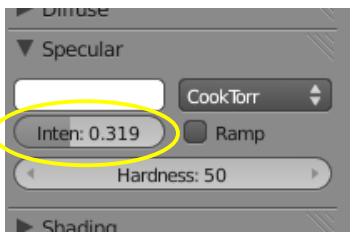
Since ground usually isn't glossy, Take the "*Intensity*" slider down to **0** (*or almost 0*) in the "*Specular*" panel. I would leave the color white here.

Now that you've adjusted the color and glossiness in the materials panel, Press "F12" to render a new image.
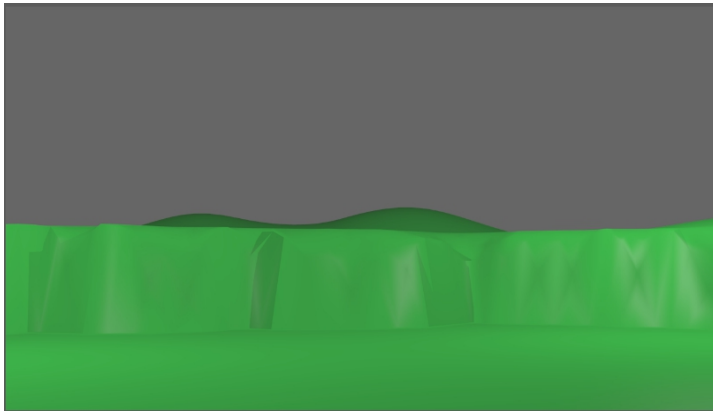
Looks better than gray, but still needs more work. We will apply a texture to the mesh soon. *Remember that you always need to place a material on an object before you can add a texture*. For future reference, if we were planning to apply an image (picture) as a texture, you would not need to adjust the color. However, you would still need to adjust specular as needed.

Lighthouse:

Now, open your *Lighthouse* model so we can work on the materials, textures, and a few other details. We will come back to the landscape later.

Let's start by cutting up your lighthouse so we can apply separate materials and textures as needed. Switch to a *front view* (#1), and enter *Edit mode* (tab). Make sure you are in *wireframe* view (*"Z" key*). Deselect all vertices using the "**A**" key (*remember-deselected vertices are pink, selected vertices are yellow*). Zoom in on the top portion of your lighthouse.
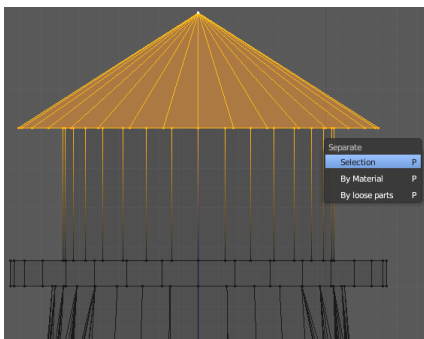
Begin by box selecting ("**B**" key) the top of the lighthouse (*roof only*) as shown. We will separate these vertices from the rest of the mesh, making it easier to apply a different material and texture to that part of the lighthouse. Press the "**P**" key to partition (*separate*) and choose the "*Selected*" option. The top of the lighthouse is now a separate mesh.
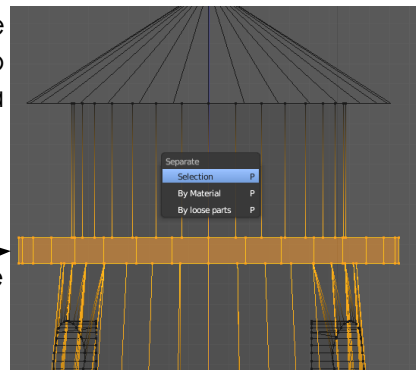
Now select all the vertices that form the walkway with the box selection and separate them using "P".
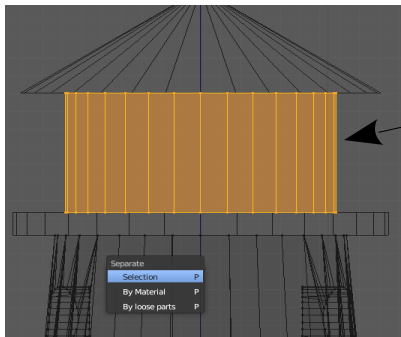
Lastly, select all the vertices that form the lighted area of the lighthouse and separate them using "P".

Exit *edit mode* (*tab*) and zoom out to see the entire lighthouse. The base of the lighthouse should be selected. Go to the *Material* buttons. Select "*New*" and name the material **LH Base**. Change the *Specular Intensity* setting down to **0.1**. This will keep the gloss down. We do not need to set a color in the RGB sliders since we will be applying an image texture to the mesh. Just to check our results so far, Press *F12* for a render.

If you notice any strange effects when rendering, it is the result of separating the mesh. Try entering Edit Mode, select all vertices and use the "Recalculate" Normals, or "Remove Doubles" options in the Tool Shelf. The may even be the possibility that you have a double mesh.
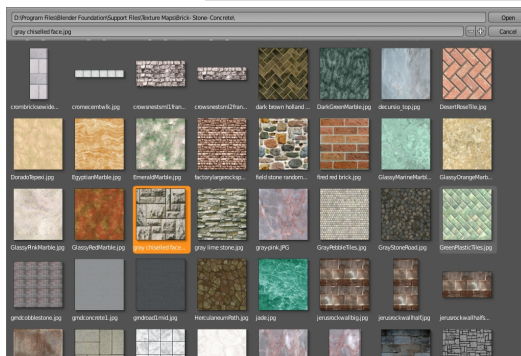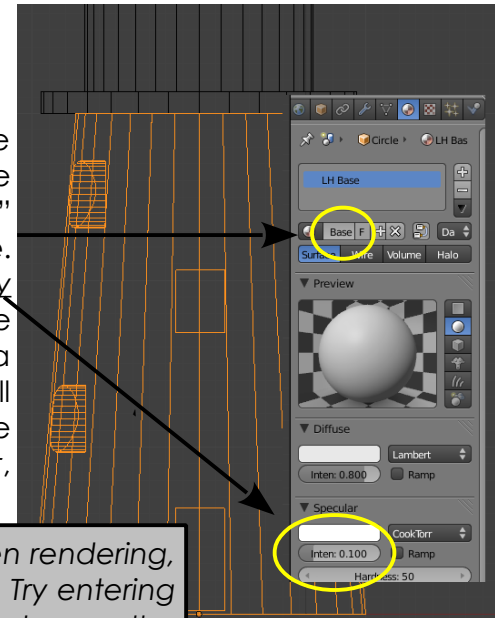
Now it's time to add a stone image in the texture buttons. You will need to find a texture to use. You can search the internet for free stone textures, look through the Blender websites for free textures, or go to www.cdschools.org/blenderbasics for a compiled zip file. Once you have some saved images, go to the *Texture* buttons and select the *Image or Movie* option. Hit "*Open*" in the *Image* panel and find a texture you would like to use. Hit **F12** to render an image:

Looks a bit distorted. The texture is being mapped *UV* and *Flat* by default which means it is being mapped to the top plane and stretched down the sides. To fix this, go to the *Mapping* panel and change the *Coordinates* to "*Generated*" and *Projection* from "*Flat*" to "*Tube*". Render another picture and you should see an improvement.
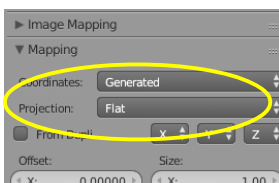
Classic Materials & Textures

The image should now wrap around the lighthouse nicely, but the stones may be a bit large. The image may also look a bit flat. It would be nice to simulate some depth to that stone texture.
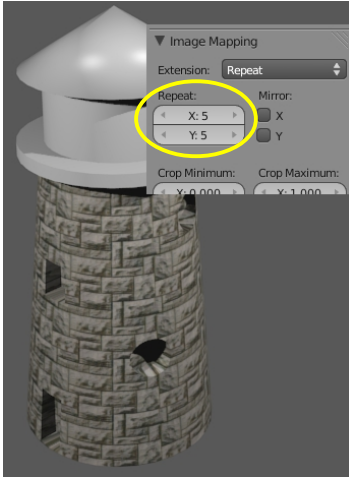
To change the image size, find the *X and Y Repeat* buttons in the *Image Mapping* panel. . Change them from 1 to a higher number. For this example, we used 5 for each, but depending on the texture you used, it may be different. If your image shows a bad line at the seams, try clicking the **Mirror** buttons by each repeat setting. This will *mirror* the image to minimize repeats.

In order to simulate depth to the stone, add a "*Normal*" to the stone texture in *Textures* under the "*Influence*" panel. This will simulate depth and add a nice effect to the stone. Some texture will work better with this than others due to color contrast. Render another image to check your results.

Continue doing this for all parts of your lighthouse to get the look you wish. You can also use straight materials on some parts. Our next step is to cut some windows in the top of the lighthouse. Feel free to try some of Blender's built-in texture generators.

Here's the final result of my texturing. A second lamp was added for better rendering. I decided to go with a straight color of red for the light area and a stucci texture with the size set as small as possible and the secondary color set to gray on the walkway to simulate stone/concrete.

Since the lighthouse will be toward the back of our final scene, it doesn't need to be "photo realistic".

It's now time to cut some windows to let the light shine out. We will do this easily by deleting faces in _edit mode_.

First, select the tube mesh and enter _edit mode_ (*tab*). Change from selecting _vertices_ to _faces_. (see page 3-5 if you forget). You'll also want to switch from *wireframe view to solid shading* ("Z" key) and hit the button to _limit selection to visible_. You will need to select every 3 faces and delete "_faces_". You will leave 1 face (as the post between the windows), and delete the next 3 faces. Continue all the way around. Since there are 32 divisions, it should work out perfectly all the way around.
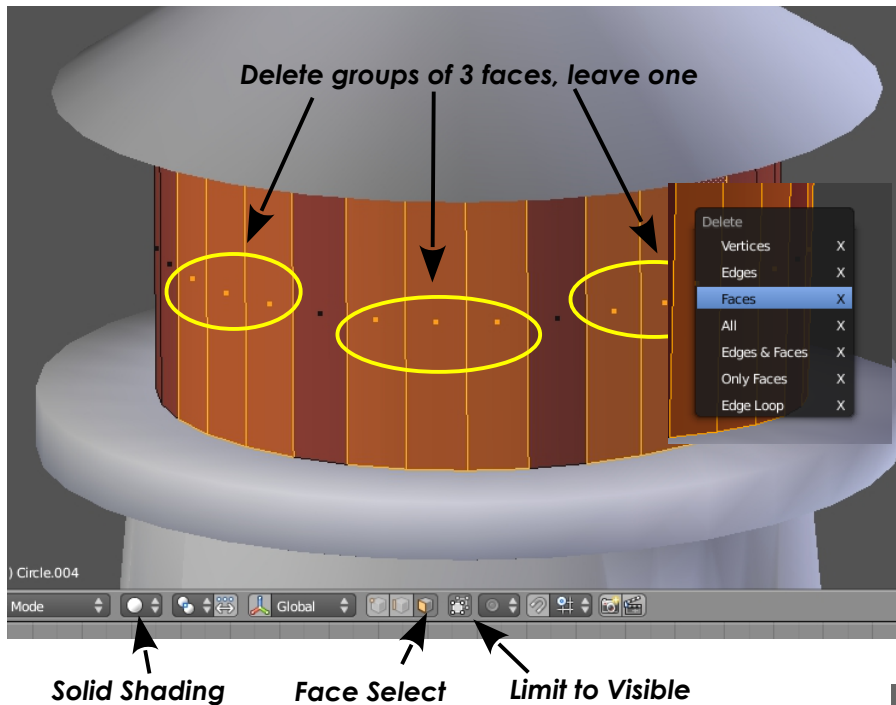
With the faces deleted, exit E*dit mode* and render a picture with F12. Your lighthouse should look something like the picture below.

Delete groups of 3 faces, leave one

Solid Shading   **Face Select**   **Limit to Visible**

Now that we're done texturing and editing the lighthouse, it's time to join the meshes back together. In O*bject Mode*, select all the meshes by RMB (right-mouse-button) clicking on them while holding down the **Shift** key. Hit **Ctrl-J** and confirm the operation. The lighthouse should once again be a single mesh. You should also have a final rendered view, fully textured! After joining your meshes, you now have one mesh with multiple materials and can see them listed in the material panel. You may need to go back and adjust them after joining, but should not need much.
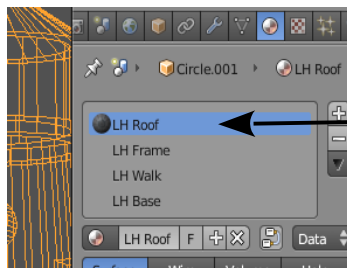
Now it's time to save the **"_Lighthouse_"** file and bring up the "**_Landscape Scene_**" again.

Classic Materials & Textures

It's now time to find a nice grass/dirt texture to use on our ground and repeat the same process we used for the lighthouse. Since we already have a material from the previous lesson, we can use it. Take *Specular Intensity* down since it shouldn't be shiny. Add a new texture and load an image of your choice. Use the *X and Y repeat* setting as needed and apply *Normal* to show depth. You may want to keep this image *Mapped Flat*. Here's the final result with a grass/dirt image that repeats well:
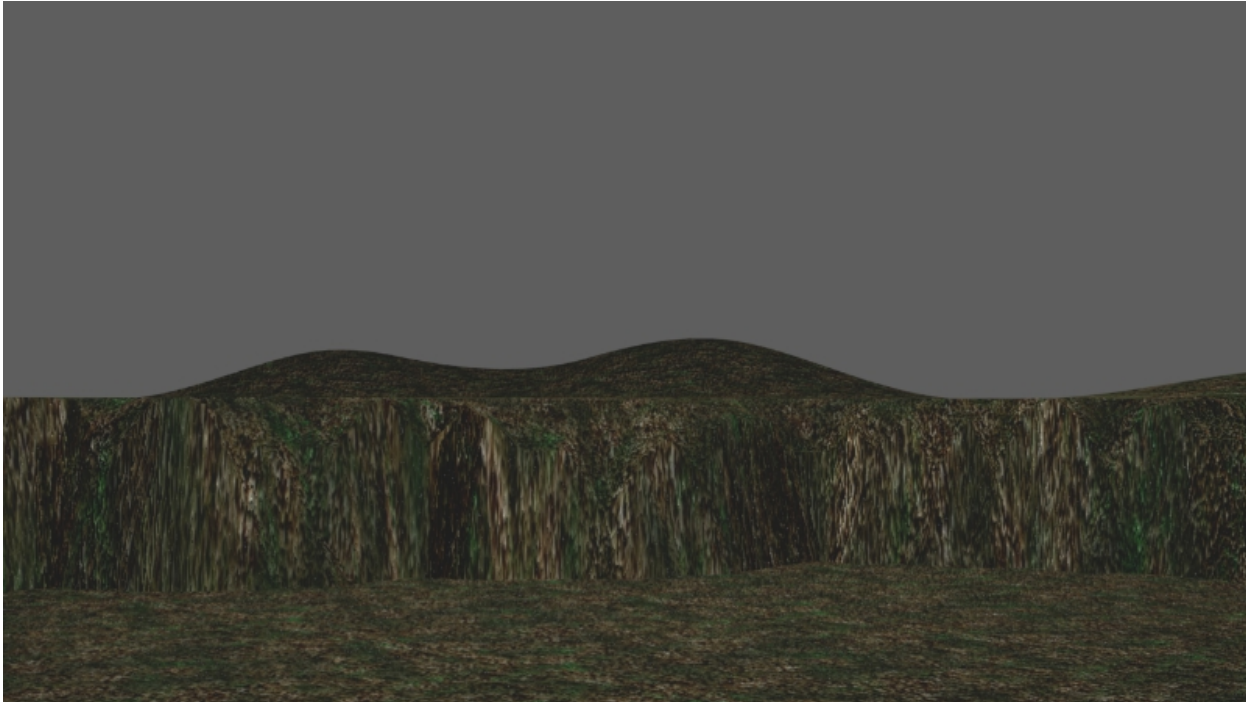
It is now time to add some water to our scene. While we can add a simple plane with some textures to simulate water, we want our scene to look like a dark and stormy night, so we will make use of a modifier in Blender that will simulate a turbulent ocean. Modifiers will be discussed in more detail in a later chapter.

Add a *Plane* to your scene and move it up to a level that will cover the ocean floor, like shown here. Do not worry about scaling it at this time.

With the water plane selected, go to the *Modifiers* panel, select "**Add Modifier**" and the "**Ocean**" modifier.

The plane will become large at this point. Scale (*S-key*) the plane down to the size of the landscape. Move it up or down if necessary to have a correct location for the water, similar as shown:
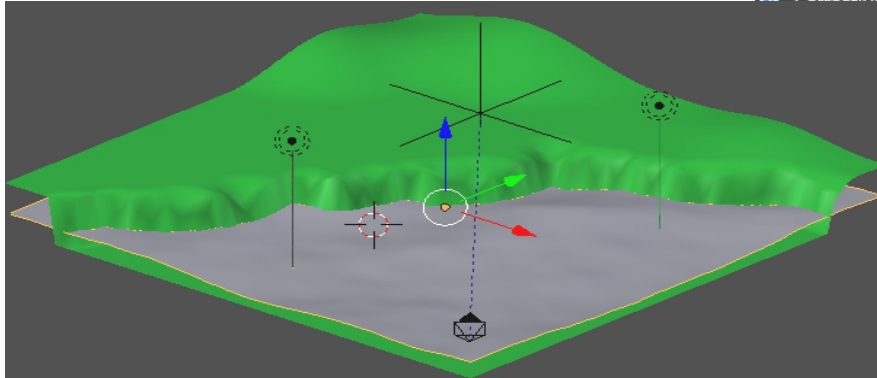
You will see some ocean wave effects, but not quite enough, so we will now make some adjustments to the ocean simulation setting.
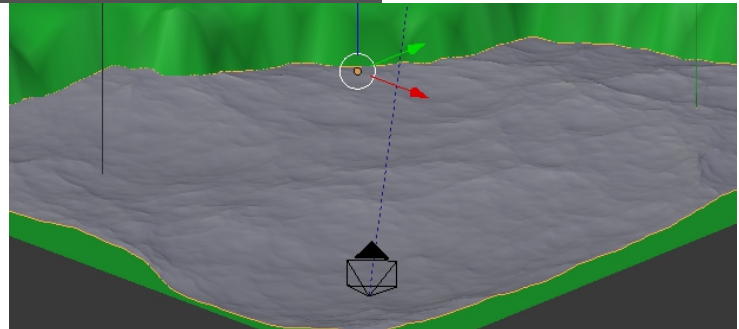
In the *Ocean Modifier* panel, Try adjusting these settings:
Resolution- 20
Choppiness- 4.00
Scale- 1.00
Feel free to experiment with any of the other settings, but this should give you a nice wave form.

Let's work on the water materials and textures. Create a material and select an bluish diffuse color. Keep *Specular Intensity* high since water is glossy. We will be using Blender's built in cloud texture type instead of an image for this one. Go to the *Texture* buttons and add a *Cloud* texture and change *UV* to *Generated*. If you render a picture, you will see the original blue and the pink color. Go back to the *Texture* buttons and change the secondary color in the *Influence* panel to a shade of blue/gray.
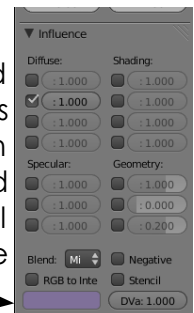
Remember that our goal is to have a stormy night so pick colors that would reflect that type of scene. Adjust both colors (Material *Diffuse color and texture color*) for the best effect. Adjust the *Normal* setting to show waves and render an image to check.

Classic Materials & Textures

Now that we've added textures both the lighthouse and the landscape, it is time to combine the two scenes together using the "**Append**" command. Select the Append command from the "*File*" pull down menu.

In Append, navigate to the folder for your lighthouse file and select the file. You will notice you have a variety of items you can bring over from the file. Go to the "Object" folder and select the "*Cylinder*" that is your lighthouse. By bringing in objects, you will bring in all materials and textures that are associated with that object. You will now see your lighthouse in your landscape scene. It will probably be too large and in the water.
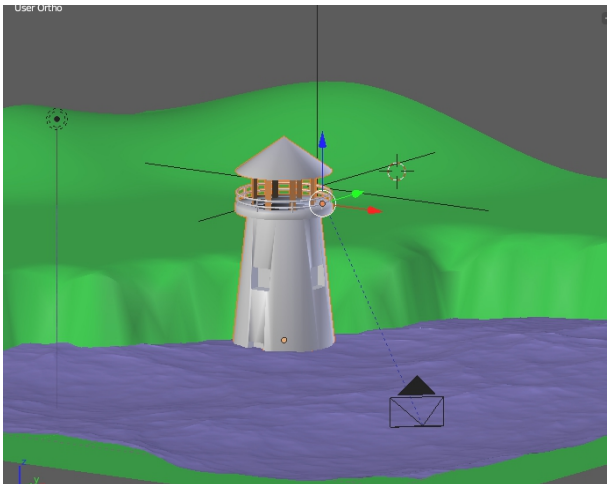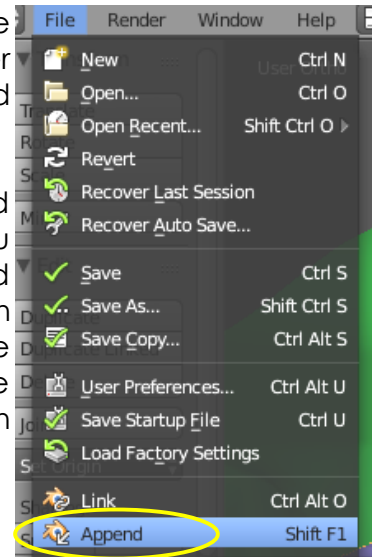
Scale and move the lighthouse to an appropriate location on the coast. Remember we left an area flat for this purpose.
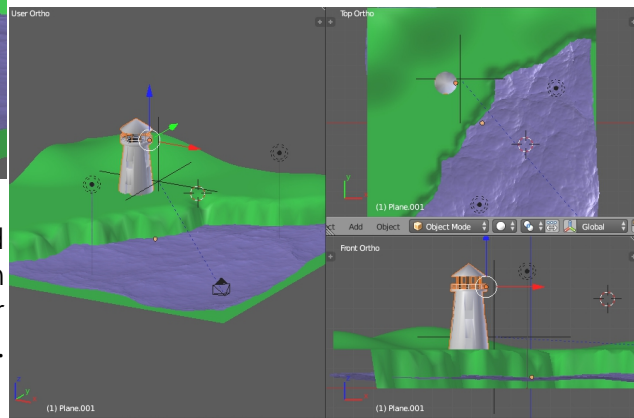
Render a final image of your scene and make any other adjustments you wish. In later chapters, we will be creating other visual effects, and animating everything. Remember to save your work!
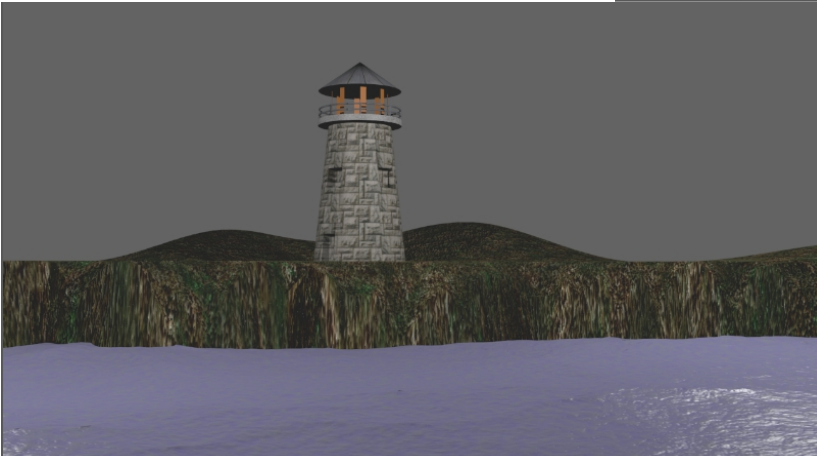
*** Call the instructor when finished ***

Now that we have used the classic render engine to shade your scene, try using Cycles to texture the lighthouse and landscape. This will require some experimentation!
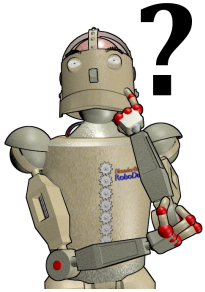
Save your landscape scene as "Cycles Landscape". Delete all of the materials from the meshes on this new file (this will keep your original file intact). Switch from "*Blender Render*" to "*Cycles Render*". Complete the following steps:

1. Replace the lamp, or lamps, with a plane and set the material node to *Emission*.

2. Add shader nodes to represent all materials and textures. Review 5-10 to 5-14 for basic Cycles material settings. You can keep your existing materials and check the "Use Nodes" button for each, but it will only translate as a diffuse color. You will need to adjust and add the nodes for textures again. Experiment with flat, box, and tube mapping for an ideal look on the lighthouse and ground. Try using a noise texture on the water.

3. Render a picture using F12.
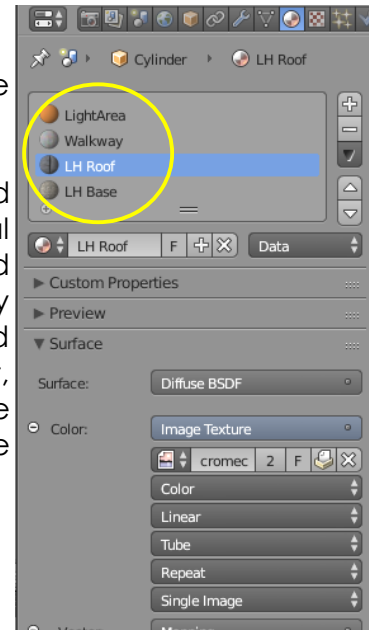
** Call the instructor when finished *

? **Chapter 5 Reflection and Wrap-up:**

How realistic do you want it to be?

You have just examined a long chapter on how to make your scenes look nice using 2 different render engines. Take some time to reflect on your experiences by answering these questions:

1. **Do you need it to look perfect or do you need it today? The animation industry is always asking this question as they complete projects. You can spend a lot of hours designing and rendering material settings. Imagine working on a weekly TV show with deadlines. Where can you take shortcuts? Imagine you are the animator. Give 2 examples in a movie where you would like fine detail in a scene and where you could get away with less detail. Explain your choices.**

2. **Which render engine did you like the best? Explain why you prefer this system over the other.**

3. **Conduct an internet search on the topic of ray-tracing in the animation industry. What is it exactly and why is it important to correctly map the path of a light ray? Why does this make Cycles more accurate than the classic renderer? Explain your answer.**

Using Color, Mist and Images
Blender Internal Render Engine

You've created a nice scene for your lighthouse, but we're missing a really nice background. Depending on which release of Blender you're running, you will either have a black, gray or blue background. Most newer releases start with a blue or gray background (a basic world set-up). Blender gives you some basic options in the **World** settings. You can control the colors of the top and bottom (**Zenith and Horizon**), fog or mist, clouds and, of course, loading JPEG images. In order to create a new world, select the **World** button. If a world has not a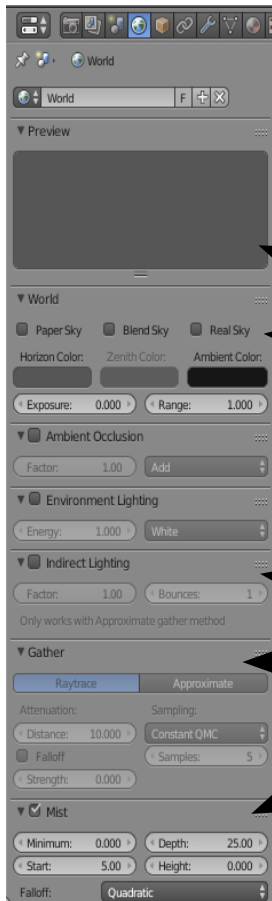lready been placed in your scene, click the **"New"**. This will give you a basic world with a horizon and a zenith color. Press the "**F12**" button to render your scene. You have some basic options that you can set in the world buttons. Here's what you see:
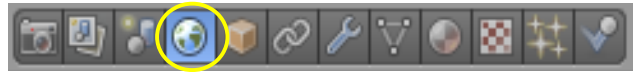
Preview Window: Sample of your world settings

Mapping Options: You can flatten (Paper), Blend (Horizon/Zenith colors), or Real Sky (gives true horizon)

Color Settings: Horizon (bottom), Zenith (top), and Ambient (reflected light). Ambient supplies global illumination.

Ambient Occlusion: Another way to simulate ambient lighting.

Environmental Lighting: Global lighting settings.

Indirect Lighting: Used to simulate light bouncing off objects. More accurate lighting effects.

Gather: Raytrace or Approximate. Approx. will allow for indirect lighting effects. (discussed in the lighting chapter)

Mist: 3D fog settings.

When setting just a straight gradient color for your world, Select the "Blend" option above the color swatches and set the Horizon and Zenith colors.

Mist Settings:
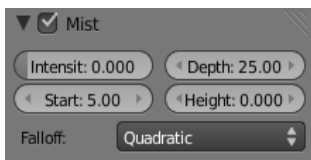
When using Mist, You will need to set both the **Zenith and Horizon colors** to the color of the mist you desire (middle gray for a real fog), turn on the *Mist* button, then adjust the **Start** (start from camera distance) and **Depth**(depth of mist). You also have a **Height** setting to vary fog height (*like fog at the ground level*). The **Minimum Intensity** slide can adjust intensity. *Depth* and *Intensity* work together for the best effects.
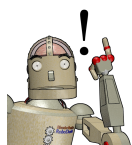
I can't see through my fog! *Your* *Depth setting is too low or Min. Intensity set too high- the fog is too thick!*
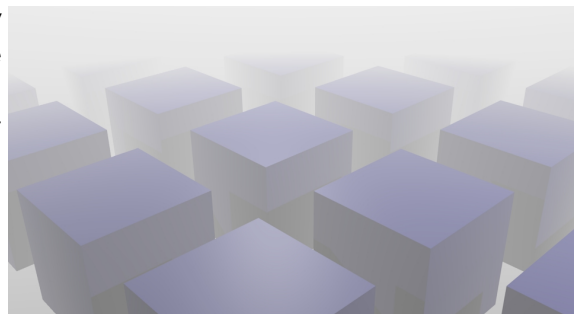
Creating a 3D Cloud Backgrounds:

There are several ways to create clouds, but the easiest is to use a texture in the world settings. To set up a scene with clouds, create a world as described previously. Set the *Zenith* color to <u>blue</u> and the *Horizon* to a <u>white</u> color (*check the Blend option*). Now, go to the texture buttons and create a new texture using *"Clouds" (you will notice that the texture will be linking to the world and not a material)* Go down to the <u>*Mapping*</u> panel and adjust the *Size X and Y* sliders (*try a low X and a higher Y*) to get the effects that you want. Press F12 to check your results. If you plan on moving the camera in your scene, you may want to hit the "*Real*" button in the World panel. Try a different Noise Basis like Voronoi F1 or F2 for a puffier look. Clouds can also be animated which will be discussed in a later chapter.
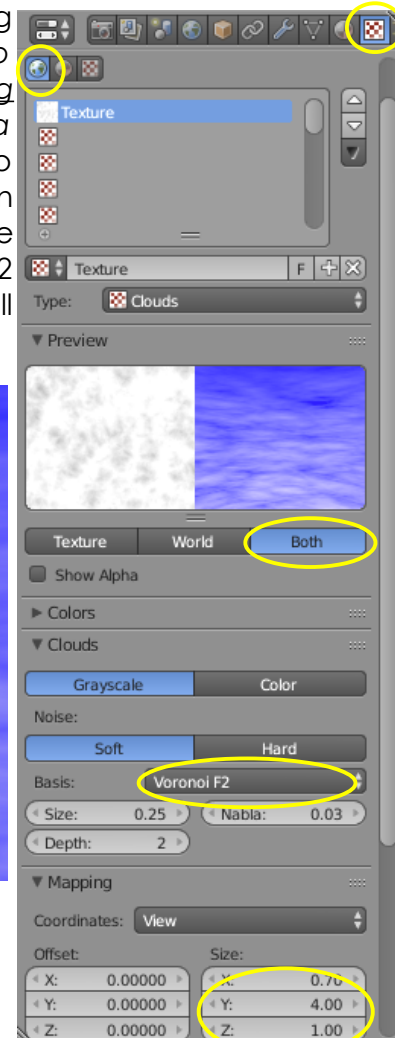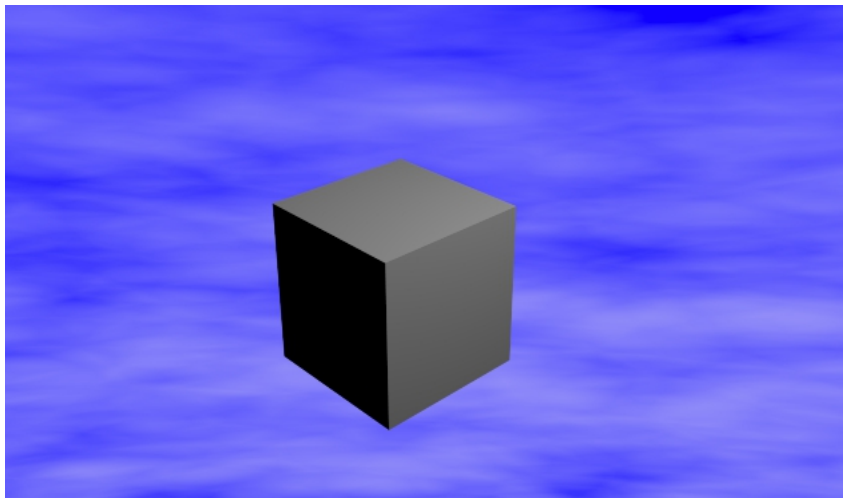
Using Cloud Textures With World Mist Settings:

If you want to simulate a puffy fog, use the cloud back-ground settings as mentioned above, but adjust your colors to match the foggy environment you want. Back in the *World* properties, turn on mist and adjust the settings to get the density for your scene. As mentioned earlier, we will discuss how to animated cloud settings in a later chapter to obtain a flowing effect.

Creating a Star Field:

Blender once had a stars world settings panel, like mist, but decided to remove the feature for some reason. This was a great tool and a way to set up a 3D star field quickly. Here is a simple alternative to that setting.

To begin, go to the *Textures* panel, making sure to check the _world_ button so the texture you create is tied to the world settings. Choose _Stucci_ for the texture type. Also, adjust the following:
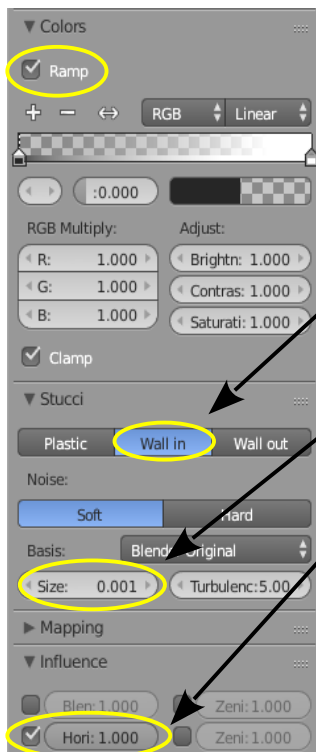
Enable _Ramp_ in the Colors panel. We will be making some adjustments here shortly.

Under the *Stucci* panel, change from Plastic to _Wall In_ and set the size to **.001**.

Under the *Influence* panel, uncheck **Blend** and check _Horizon_.

If you press F12 at this point, you should have a heavily spotted background scene. To fix this, go back to the color ramp and pull the left slider to the right on the ramp until the preview displays the star field you want.
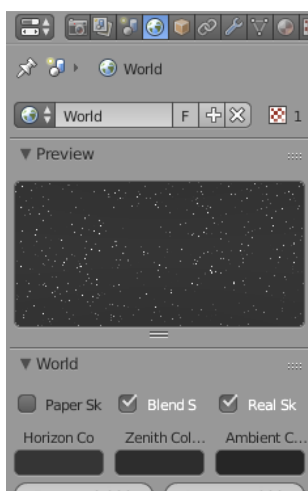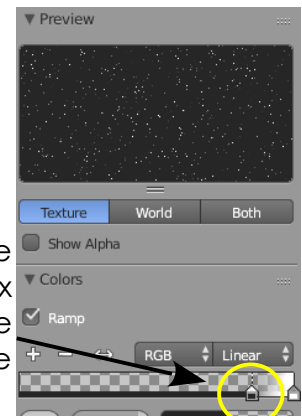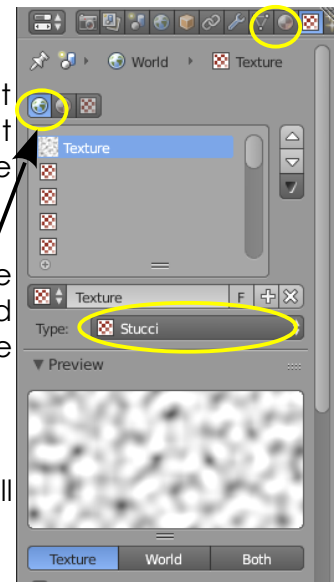
Go back to the World settings, check both the "_Blend Sky_" and "_Real Sky_" buttons. Adjust the *Horizon* and *Zenith* colors to match the output you want. Press F12 to render your results.
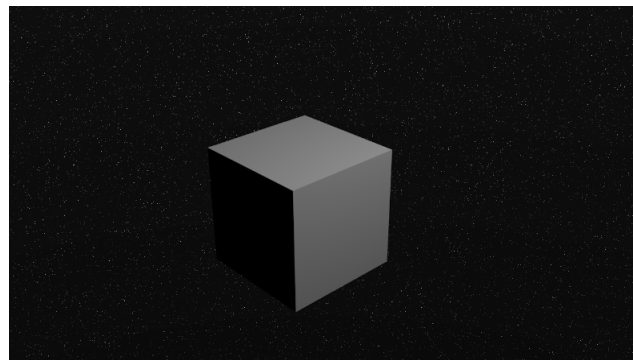
Chapter 6- Setting Up a World

Using an Image in the Background:

If you plan to use an image in your world settings, use one that is large and high quality. Low resolution images have a tendency to be grainy and unrealistic. To use an image, **create a world** as described before, then go to the **Texture s**ettings. This time, select the "***Image or Movie***" type option and select your image (described in the *Materials and Textures* chapter). If you press the *Both* button in the Preview window, you will notice the image does not display (same as pressing F12).

In order to display the image, go to the *Influence* panel. You will notice that *Blend* is already checked, but you will need to check the *Horizon*, *Zenith Up* and *Zenith Down* button. This will cause the image to influence both the horizon and zenith world settings, taking the place of the colors. If you press F12, you will see the image in the rendered view, but it will be zoomed in.

To see the entire image in rendered view, go back to the world settings and check the *Paper* button to flatten and fit the image.
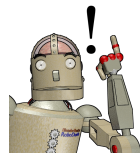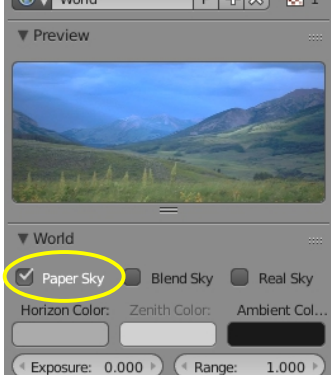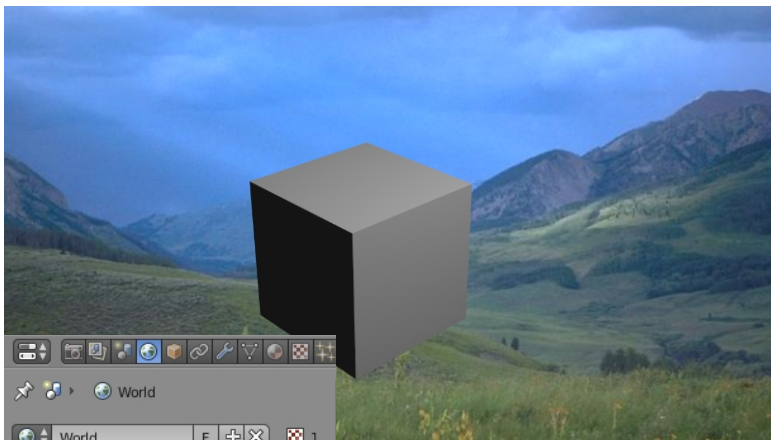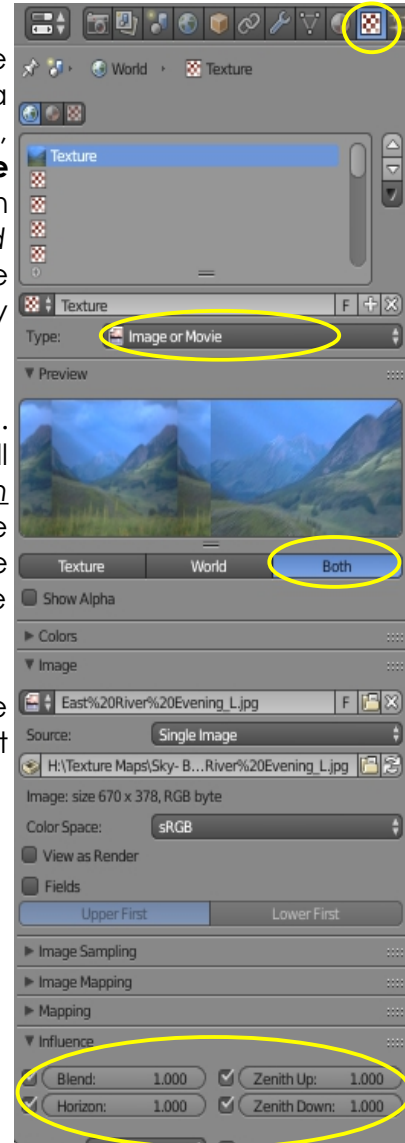
RoboDude Asks: *How do use an image that moves when I move the camera?*
If you want to animate movement in your scene and want the background to move as you move the camera, these world settings won't work for you. You will need to find a panoramic image that you can wrap around a sphere or cylinder and scale it larger than your scene. You can also use a large plane, like standing in front of a billboard .

Cycles World Settings

Just like using material settings, setting up a world in Cycles is very different than setting up a world in the internal renderer.

After selecting Cycles from the drop down renderer menu, go to the _World_ buttons. To set just a basic color, you can do that without having to use nodes.
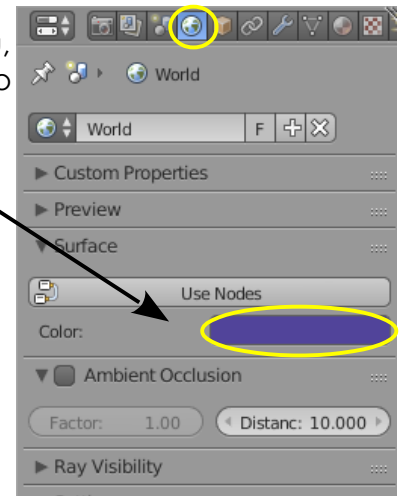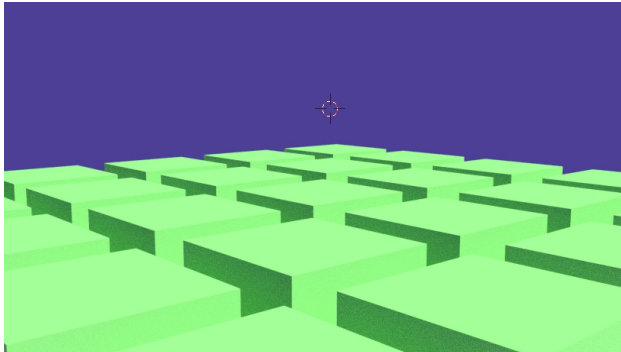
Setting Up a Simple Sky:
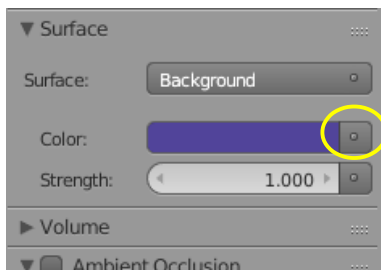
To set up a simple sky with horizon and zenith, enable Nodes. The surface shader will automatically be set to _Background_ since you are in the world settings. By pressing the small dot button in _Color_, you can change it to use a _Sky Texture_.

Some of the setting options include changing the type, sun direction, and intensity through Turbidity, Ground Albedo, and Strength.
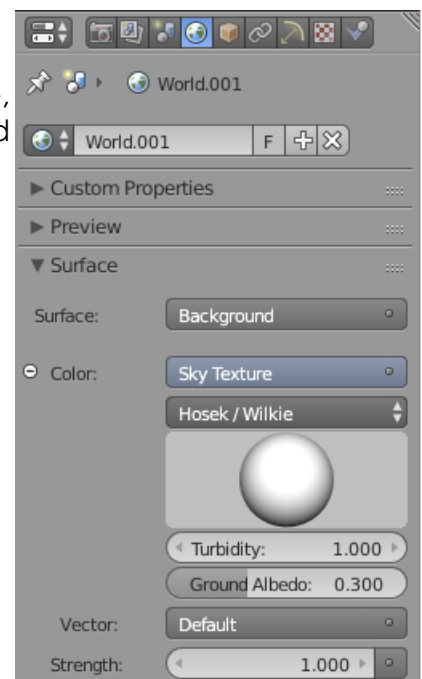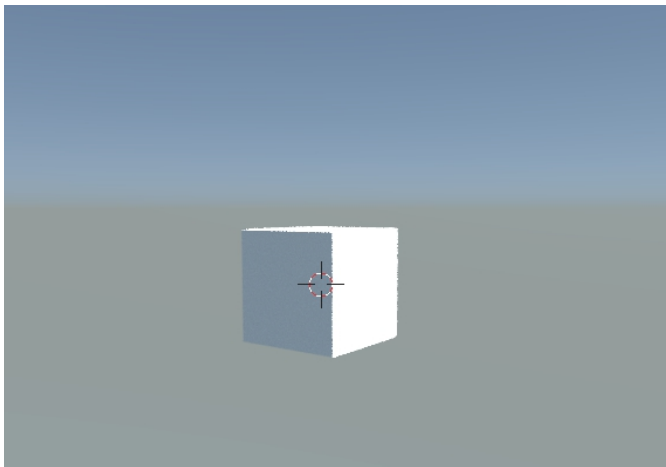
Mist in Cycles:

Like many things in Cycles, setting up a mist can be more difficult than in the classic render engine, but can give you more realistic results. There are many ways to create a mist, but here is one of the more simple ways.

First, set the render engine to *Cycles* in the top menu bar, then go into the *Render Layers* properties settings. Check "*Mist*" under the *Passes* panel. This will enable the mist settings in the *World* properties.
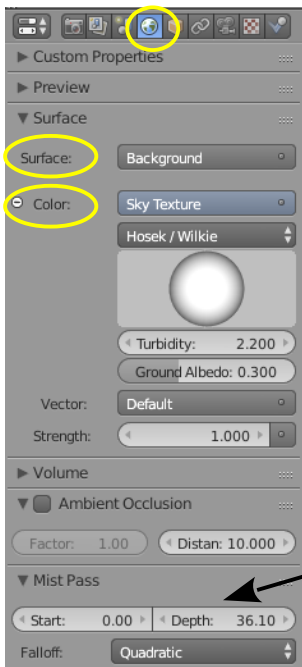
Now go to the *World* property setting, use nodes to set a *Background* surface and using a *Sky Texture* for the color.
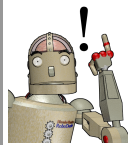
RoboDude Says:
The Mist options won't be visible unless you enable Mist in the Pass panel in the Render Layers properties.
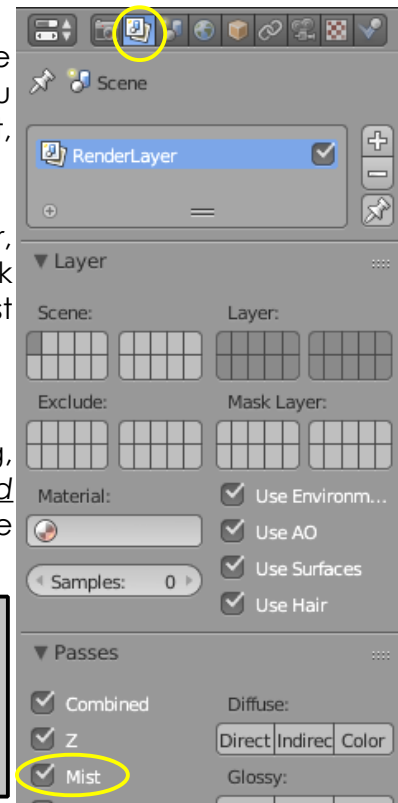
The *Mist Pass* can be set with a *Start* and *Depth* to match how close you wish the mist to start from the camera and how deep it projects into your scene.

Press F12 to render an image. Now that we have a basic setup, it's time to move over to the Node Window and add the following:

Add a Viewer node from the Add-Output node menu. Connect to the Render Layers panel to render a backdrop image.

Switch to Compositing nodes.

Check Use Nodes, Backdrop, and Auto Render.
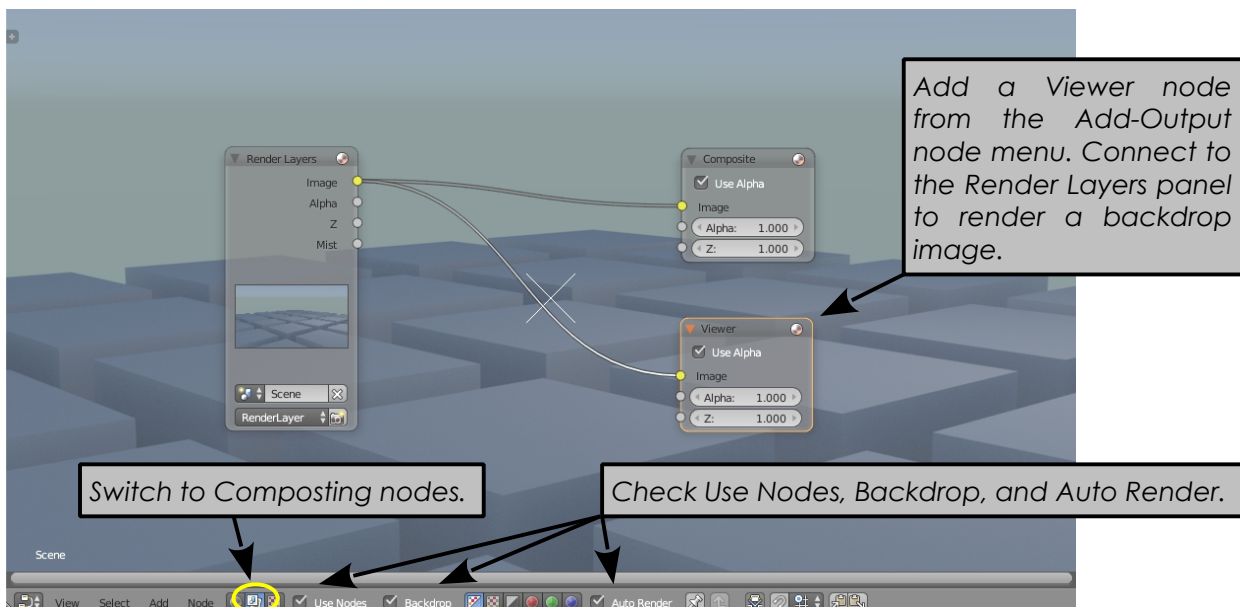
Temporarily connect the *Mist* output of the *Render Layers* panel to the *Viewer's Image* port. This will allow you to focus on the mist's settings for the next several steps. The darker an object is in this view, the less it is effected by the mist.

Now it's time to add two more nodes- A *Mix* node from the Color menu and a *Map Value* node from Vector menu. Connect the *Mist* to the *Map Value* input with the *Map Value* output connected to the *Factor Mix* input. Connect the *Render Layers Image* output to the *Mix Image* input. The *Mix Image* output connects to both the *Composite* renderer and the *Viewer* output. You can now adjust the color of the mist using the color swatch in the Mix node. You can also adjust the density of the fog using the offset and size settings in the Map Value node. You can also experiment by checking and adjusting the Use Minimum and Maximum settings.
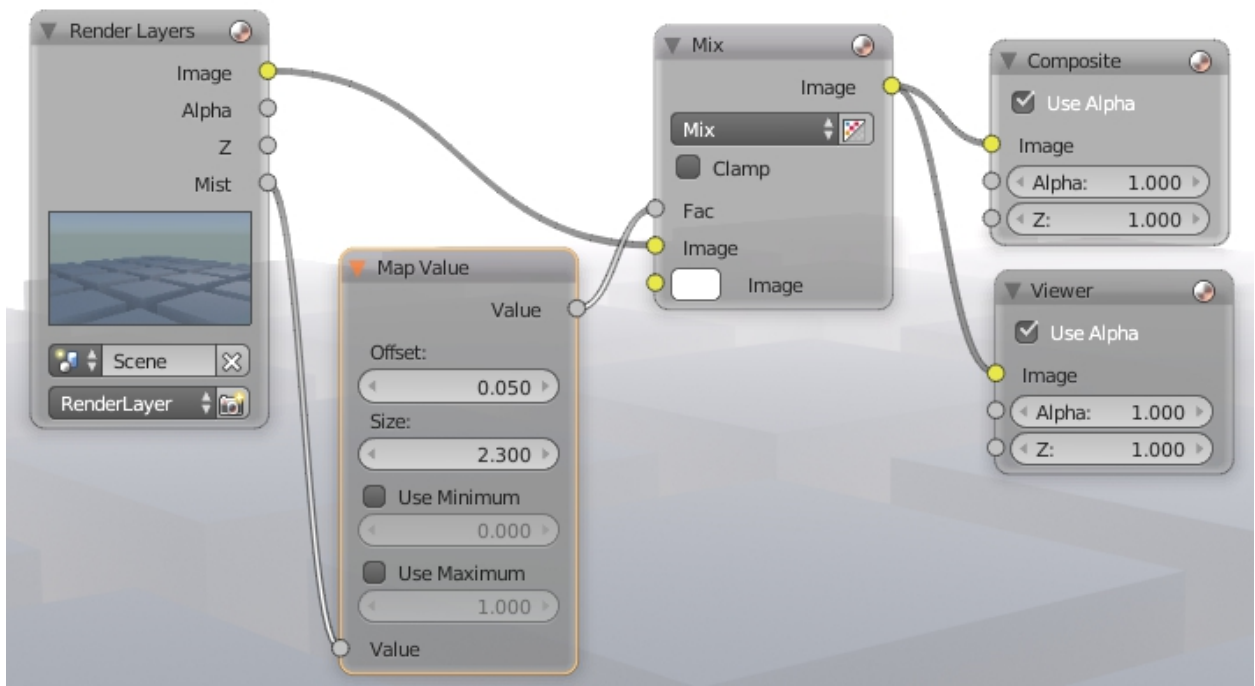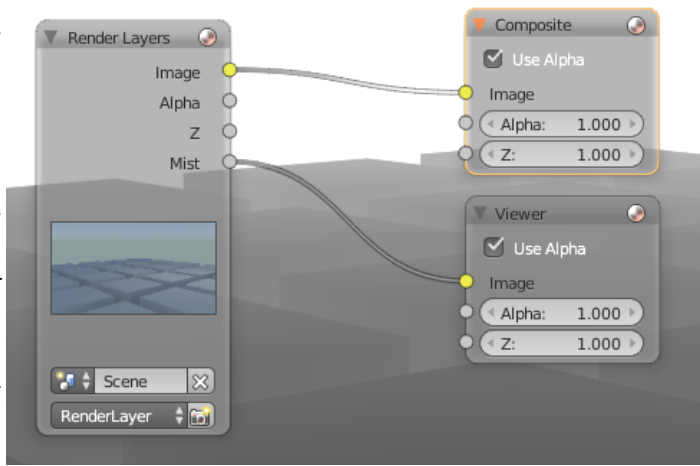
An internet search will turn up a dozen more ways to set up a mist, but this will give you a good, basic result.

Using a Background Image in Cycles:

Background images can work much better in Cycles than in the internal render engine. When using the Rendered view port display in your 3D window, you can view the background through the camera and watch it move as you move the camera.

In the World properties panel, add a world, set the surface to _Background_, color to _Image Texture_ and select an image to use. Panoramic images can work best. For vector, set to _Generated_. This will give you an initial setup that should display when rendered with F12 or in the view port set to rendered shading. In order to make adjustments, switch over to the Node Editor window. Add the following nodes and adjustments shown below:

In the Texture Coordinates node, set to Camera, Window, or Object and set the object to Camera.

Add a Mapping node from the Vector node group. Adjust the Location, Rotation, and Scale for a desired look.

Adjust the Image Texture node (typically set flat) settings.
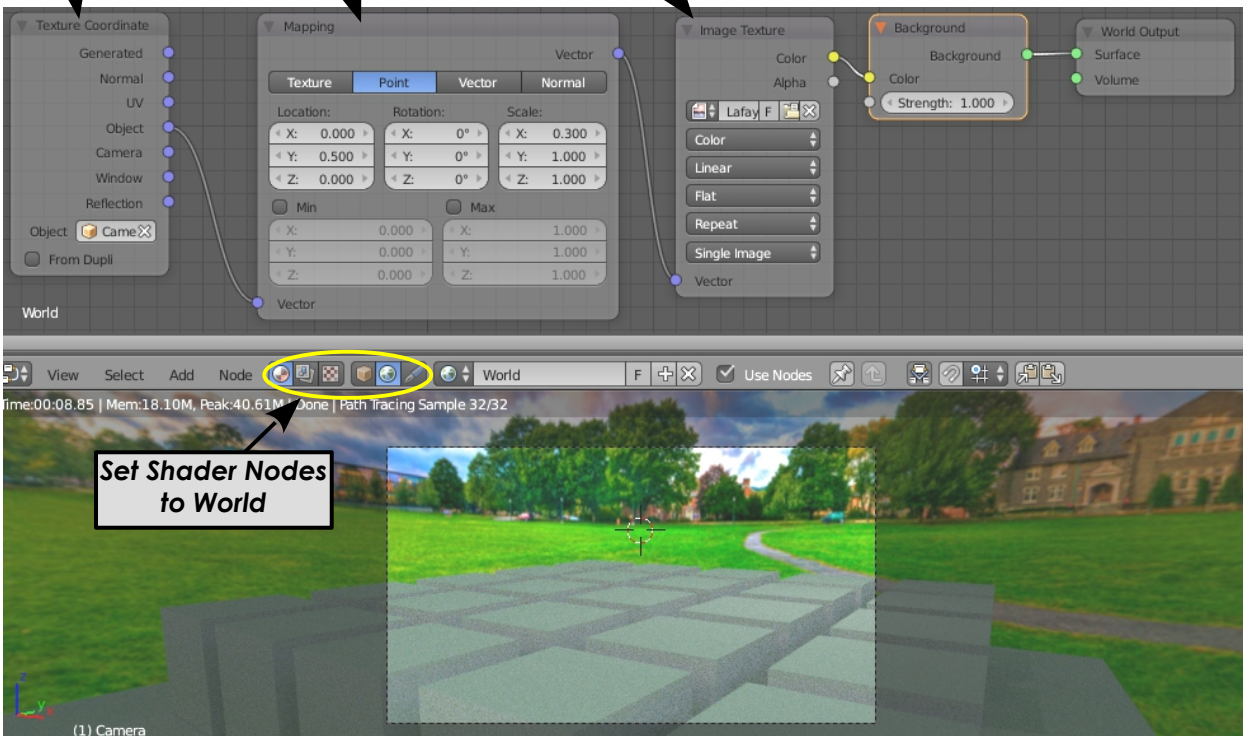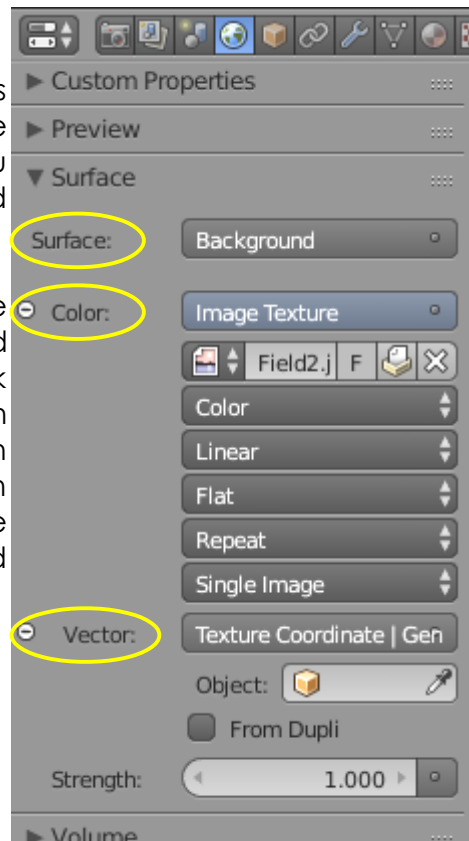
Set Shader Nodes to World

Stars in Cycles:

Like everything else in Cycles, there are easier and more difficult ways to create stars. Here is a relatively simple way to create stars. Start by making sure you are in the Cycles renderer and add a world using nodes. Switch to the Node Editor window to add and set the following nodes:

Noise Texture (from Texture nodes)- Basic setting:
Scale: 300-500
Detail: 5-15
Distortion: 0.05

Color Ramp (from Converter nodes)- Controls the size and number of stars. Set the ends of the ramp like shown.

Bright/Contrast (from Color nodes)- Can be used to fine adjust results. Keep changes small.

MixRGB (from Color nodes)- Colors 1 & 2 represent the sky and star colors. Connect to *Factor*.

Background (from Shader nodes)- Process for the world output.
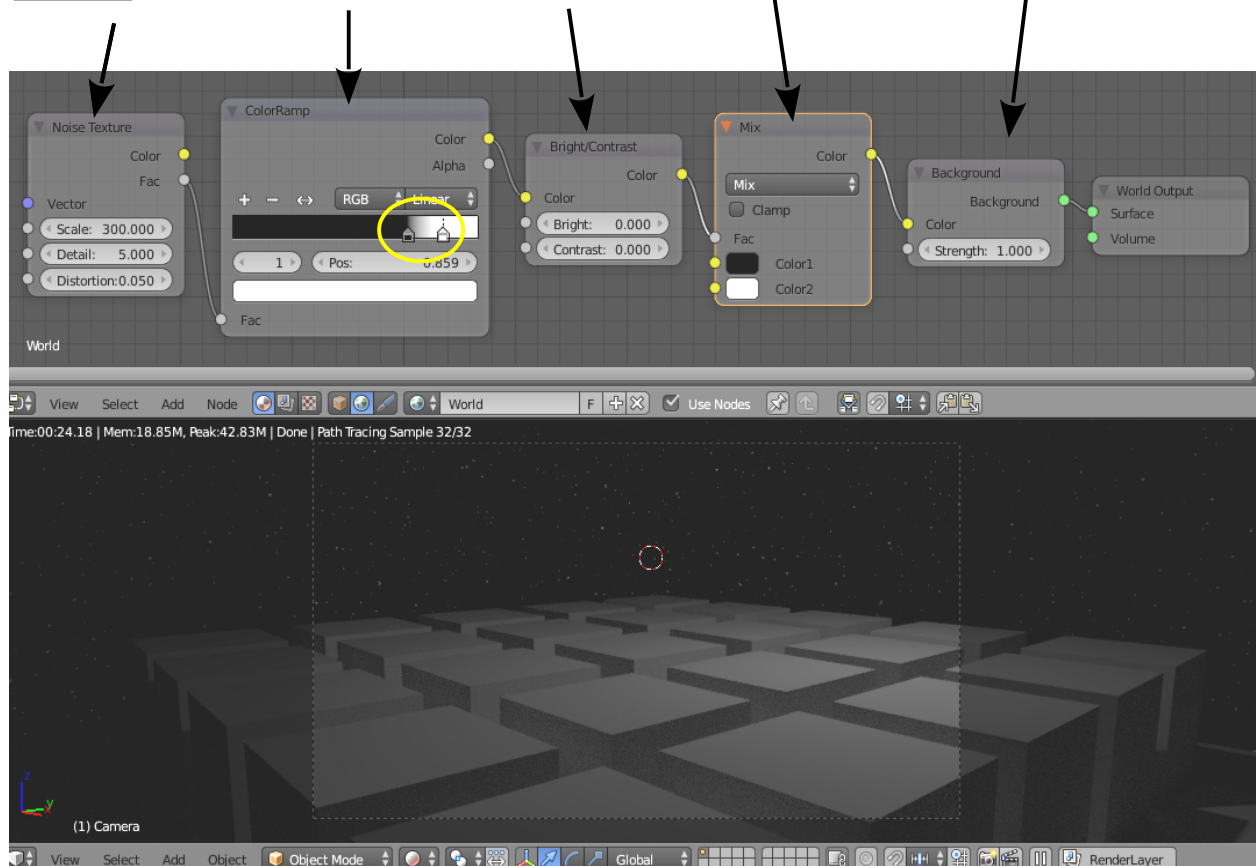
Continue making adjustments until you get the results you desire. Pressing F12 will probably give you better results than the view port rendering.

As people keep coming up with new and unique ways to use nodes, Blender Cycles will continue to evolve with new features. The Blender forums and YouTube are great resources for finding new applications and new node combinations.

Adding an Environment to Your Scene

It is now time to add a world to your lighthouse scene. Start by opening up your "**Lighthouse/Landscape"** scene for the internal renderer. We will add a world using the traditional render engine for this activity. Feel free to experiment with any of the settings, but we are actually looking for a "dark and stormy night", say, at late day or dusk. I imaging it being foggy, with a billowing effect.
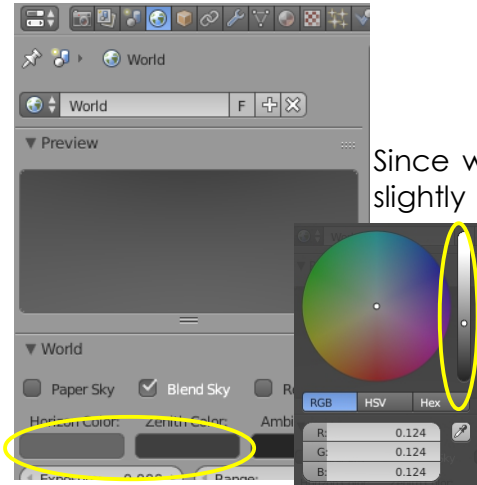
Since we want a fog, set the _Horizon_ and _Zenith_ colors to 2 slightly different shades of gray. To do this, you can click on the color swatches and pick the gray from the menu blocks. Press the "_Blend_" button as well if not already set.

Turn on the **Mist** button and start with a _Depth_ setting of about **23**; _Intensity_ at **0**; _Start_ at **0**; and _Height_ at **0**. Render the image and make adjustments as needed. Your goal is to be able to see the lighthouse, but be a bit foggy.
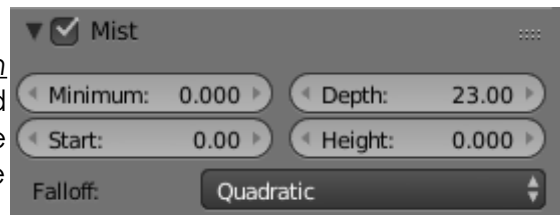
You should try for something like the render below:

This foggy scene looks good, but it would be nice to see some depth. Many times, a fog can appear "billowy" with varying density. For this, we will add a *Cloud Texture*. Go to the <u>Texture</u> buttons and add a <u>Cloud</u> texture. Make sure <u>World</u> is selected by the preview. Try different <u>Noise Basis</u> settings to get the look you want.

At this point, go back to the <u>World</u> buttons, render an image and make adjustments as needed. You can adjust the sizes of the cloud texture, adjust the colors, work with the mist settings (*Depth and Intensity*). You may also want to go back to the texture settings and adjust the Noise Basis. We will animate this fog rolling by in a later chapter.

The settings used for the render below are:
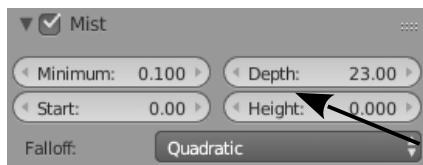
Texture Settings:
Basis: Voronoi F1- Size 0.05
Mist Settings:
Intensity 0.100; Depth 23.00

** *Call the instructor when finished** *

Remember the sculpture you made in unit 3? It is now time to add an environment to that scene to make your sculpture look like it is standing in a prominent place in nature using **Cycles**. Experiment with the various Cycles world settings to get a scene you like.

Remember to switch to the Cycles renderer at the top of the screen, create a Cycles emission lamp, and set the camera in a desirable location. Determine if you plan to use an image, like the example displayed below. Add some materials to your sculpture as discussed in the materials chapter. Feel free to explore the internet for other material and world settings that others have tried.

*** Call the instructor when finished***
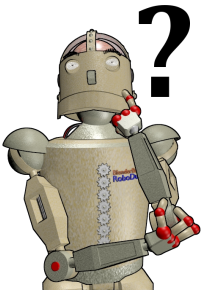
Chapter 6 Reflection and Wrap-up:

Creating a World

You have experimented with the internal renderer and Cycles to create environments for your scenes. Answer the following questions:

1. **How has your view of 3D animated movies changed now that you have a basic understanding of 3D modeling, texturing, and world settings? Specifically, what has changed your perception of these movies? Explain.**

2. **Conduct some internet research. We have examined basic sky scenes in this unit, but how would you create an underwater scene? How about a space scene with planets or a sunset? Explore the internet to find information about one of these and report your findings. How difficult are these scenes to create?**

Cameras:

By default, your scene already has one camera and that is usually all you need, but on occasion you may wish to add more cameras. You add more cameras by hitting "*Shift-A*", like creating all other objects discussed up until now. *To change which camera is active, you need to select that camera and press "Ctrl" and number pad "0".* This changes the active camera.

Like all other objects in Blender, you can adjust the camera settings as well. *With the camera selected,* click on the **Camera button**. Here are some of the settings options you have:

Perspective/Orthographic/Panoramic- Used to set the camera from showing a true-life perspective view to an orthographic view. Panoramic can give a 360 degree view <u>in Cycles only</u>.

Lens (Focal)- Set-up a lens length much like a real camera. 35mm is a good, safe setting, but wide and tight angle setting work for different needs.

Shift- Pushes the view left, right, up, down from actual camera view, without changing perspective.

Clipping- Start and End- How close and how far an object can get to the camera and still be seen. In very large scenes, this needs to be set higher or things "disappear" from view.

Camera- Used to set a specific make of camera for your scene. You can select a specific camera or set your own.

DOF- (Depth-of-field)- Used with nodes to blur foreground and background objects. This will be discussed in the "*Working with Nodes*" chapter.

<u>**Display Settings:**</u>

Limits- Draws a line in the scene to help you visualize the camera's range.

Size- How big to draw the camera on the screen. You can also control size with scale.

Show Mist- Used to give you a visual display of how far the camera sees if using Mist (discussed in Chapter 5).

Name- With all objects, the name of the object or camera can be displayed on the screen, but this will display the name in the camera view.

Passepartout- Shades the area on the screen outside of the camera's view. You can control the darkness of the shaded area with the **Alpha** slider.

Title Safe Areas- Displays a dashed box to help with placement of objects and text.

Using Nodes for Camera Effects:

Up to this point, we have only used nodes for Cycles materials, but node can be used with the internal renderer for camera effects as well.

Depth-of-Field- Internal Renderer:

A great node feature is creating *Depth-of-Field* effects. Just like a camera shot using a low F-stop setting that creates blur behind and in front of what the camera is focused on, we can create in Blender. *This process if for the Internal Render Engine.*
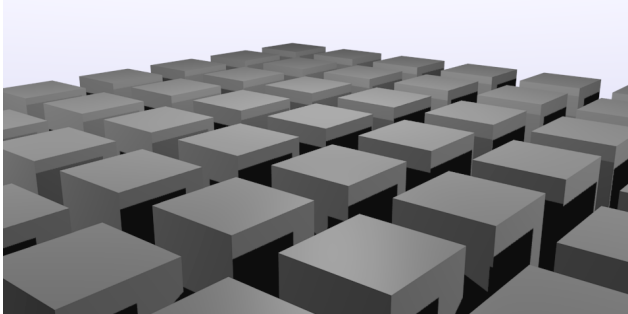
To start this scene, I've created a grid of cubes. The camera is tracked to an *Empty*, placed directly on the center cube.
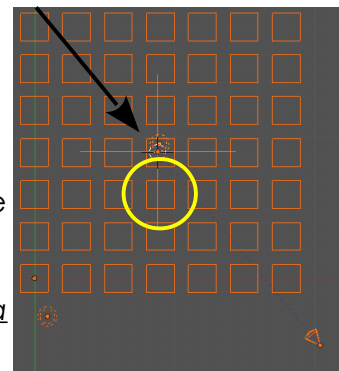
Notice everything is in focus above. We want to blur the foreground and background.

With the camera selected, go to the *Camera's Object Data* panel to set a few things.
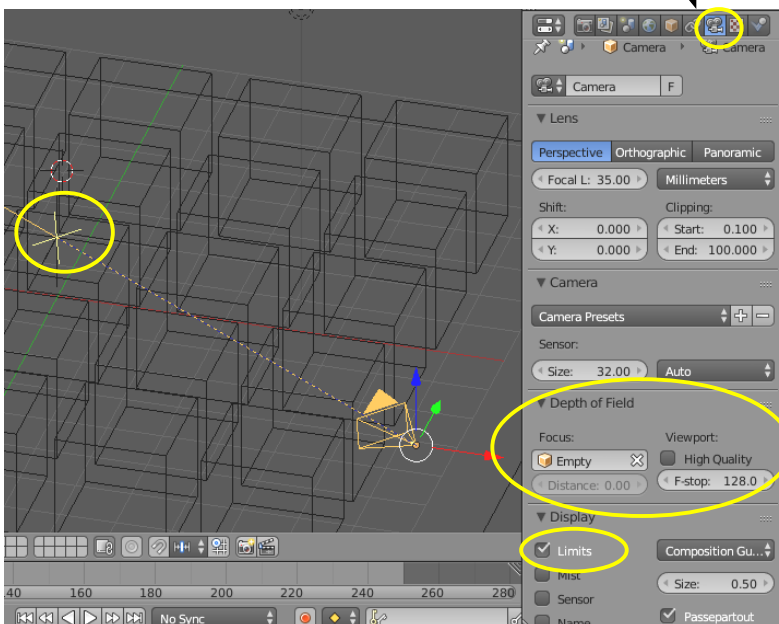
You have 2 ways to set the *Depth of Field*. You can select an *Object* for the camera to target (*great for animation*) or you can set a *Distance*. In order to see the actual target point on the screen, turn on "*Limits*" in the *Display* panel. The target point will display on the dashed line. All of this can be animated, much like you would see done professionally. This will be discussed in a later chapter.

It's now time to work on the nodes.

In the *Node Editor* screen configuration, enable nodes by checking the "*Use Nodes*" button, also set for "*Compositing Nodes*". If you would like to render in the background, enable "*Backdrop*" as well.

Delete the line connecting the *Render Layers* and *Composite* panels. We are now going to add 2 nodes. Add a "*Map Value*" node from the *Vector* node set and a "*Defocus*" node from the *Filter* node set. If you would like to render in the backdrop, add a "*Viewer*" node from the *Output* node set.

Set the nodes up as displayed below and match settings:
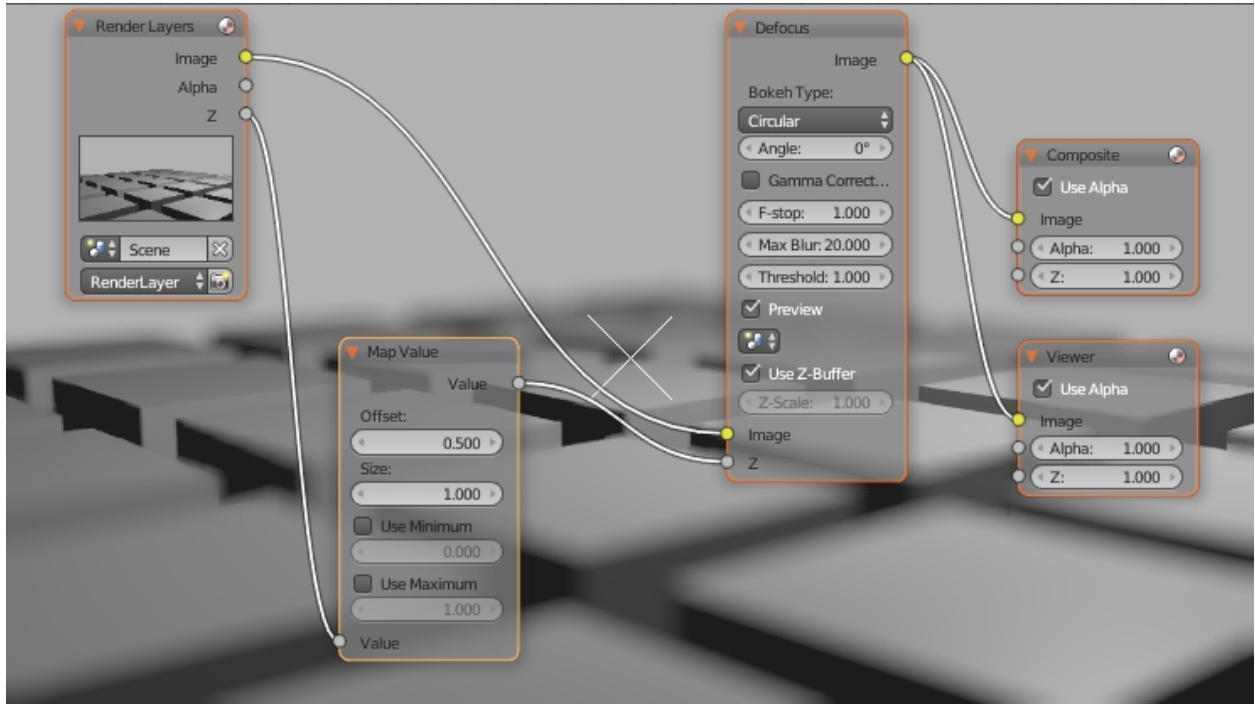
The "Map Value" panel is used to adjust the pixels related to distance from camera and connects to the "Z" on the *Render Layer* panel and *Defocus* panel. The image Out/Ins connect as shown. Adjust the *F-stop* to a low number. Like a camera, a low fStop means little is in focus beyond the target. A larger number will give a larger focus range. *Max Blur* sets the amount of blurring while a high *Samples* setting will give you a better quality image. Experimenting with these settings will give you different results.
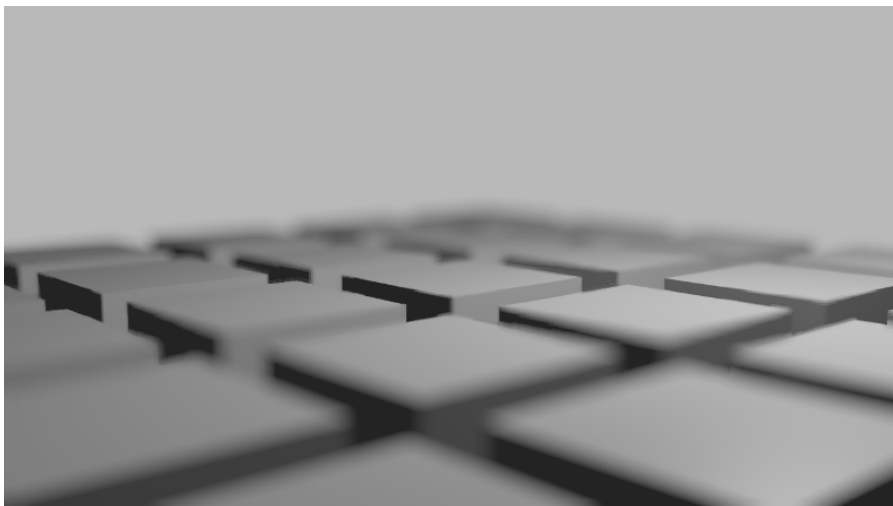
Motorcycle with focus at headlamp
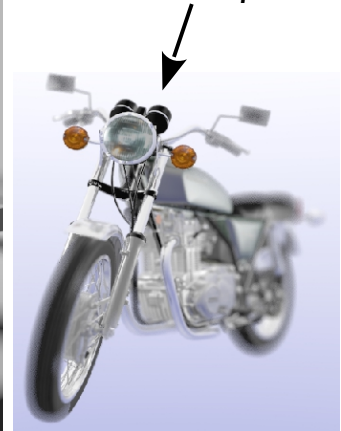
Depth-of-Field- Cycles Renderer:
Using depth-of-field is actually easier in Cycles than in the internal renderer. You can use simple DOF in the Camera properties panel and not even enter the Node Editor window.

First, set the Cycles Render engine in the top bar, select the Camera, and go to the _Camera_ properties panel. You will notice a few more options in the DOF panel than you have using the internal render engine. Set the _Focus_ target or Distance as before, Lower the _F-stop_ setting for blur (about 1.0), and set the Size of the _Aperture Radius_ to about 0.2. This should give you a good blur effect. Adjust the numbers as needed.
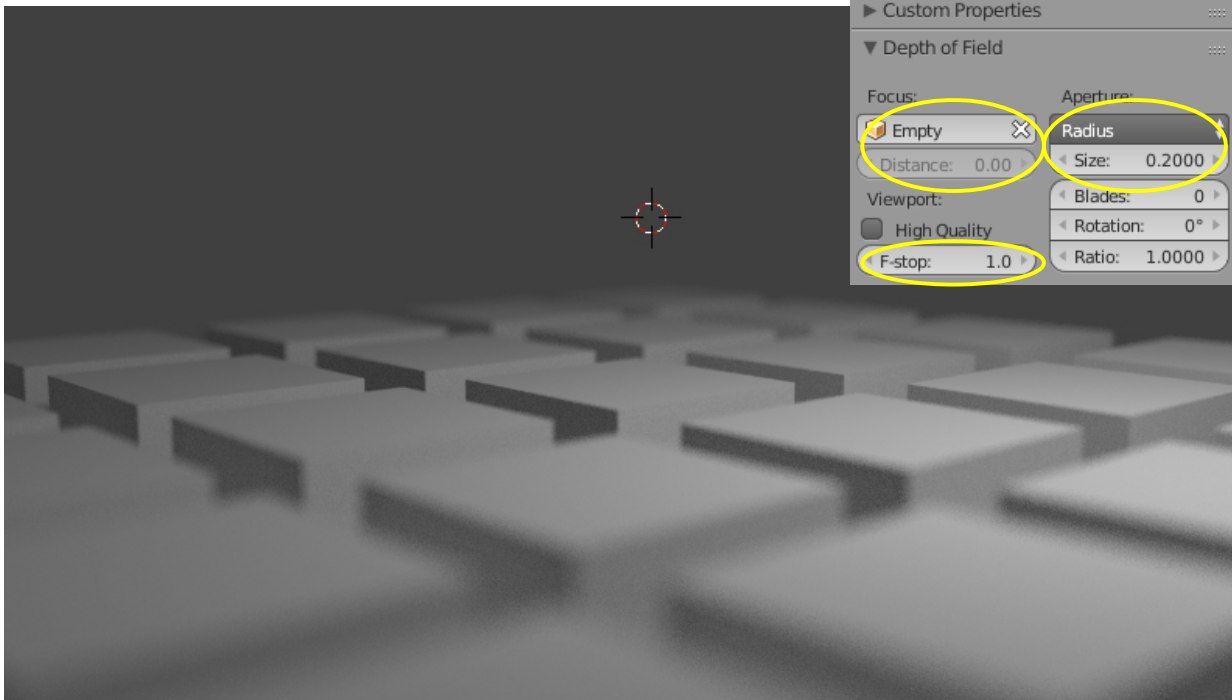
Other Camera Node Effects:
These node effects work with both the internal renderer and the Cycles renderer.

To the right is a basic rendered view without any special nodes applied. On the next page, you will some sample node settings applied that can alter the output:
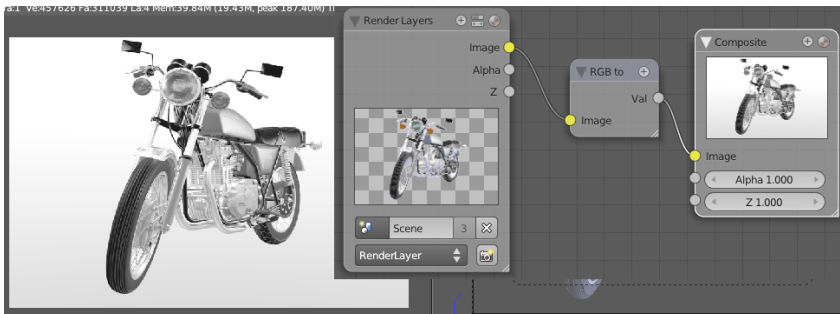
Black and White output using an **RGB to BW** *Convertor* Node.*Inverted* output using an **Invert** *Color* Node.

Inverted output using an **Invert** *Color* Node.
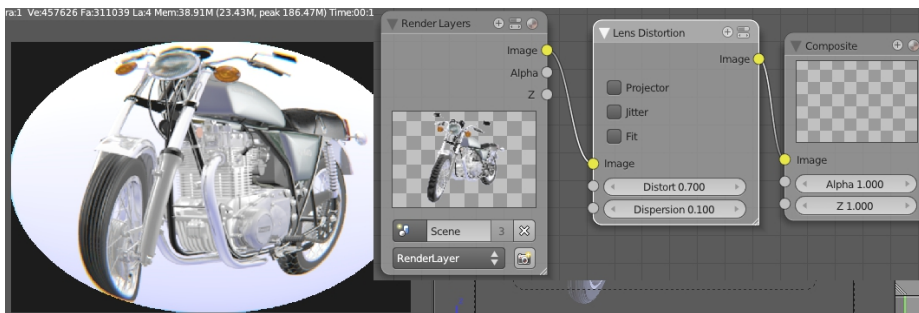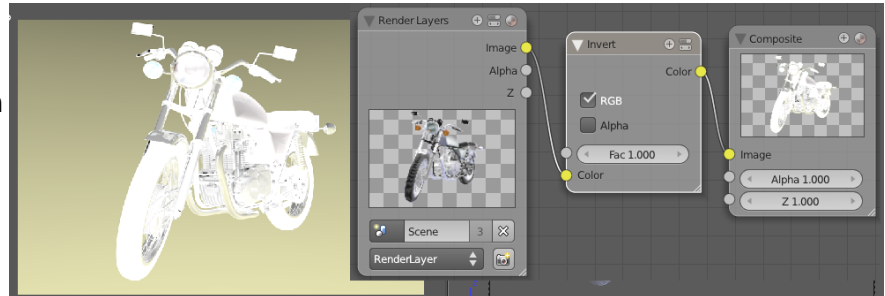
Camera lens output using a **Lens Distortion** *Distort* Node.

The possibilities are limitless using nodes. Search for some creative tutorials using nodes on the web.

Using the Chroma Key (Green Screen Effect):
Blender can be used for video composite work and motion tracking (combining 3D elements with real video), like you see in professional blockbuster films and advertising. Motion tracking and video editing are handled in later chapters, but we will discuss setting up nodes for chroma key composites now. Chroma key composite work basically involves video taping a subject in front of a colored screen (typically green), and then replace the green color with some other graphic or movie. Weather forecasters use the chroma key feature to project weather maps behind them during news reports.

Your first step is to film or obtain a video of the subject in front of a green screen (*or other color not in the scene*) and the image or video you plan to put behind your subject. For this example, we are using a video of a well known person in front a green screen and video of the Pennsylvania capital fountain for the backdrop. *For best results, the films should be the same size and frame rate to match your output settings. Use a video converter to correct differences.*

Now, you will need to set up the nodes as shown below in the Node Editor:

Keying Settings:

While you will want to experiment with all of these settings for the best results, start with these recommendations.

Pre Blur- *Blurs the video to match output.*
Edge Kernel- *Gets rid of the outer glow on the shape.*
Clip Black & Clip White- *Sets the solid black and solid whites in the image to improve edges and washed out areas.*
Key Color- *Click on the color swatch to select the color to remove from the image. Use the eydropper to select the green on the movie clip preview.*

You are using two "*Movie Clip*" nodes from the *Input* node group, a "*Keying*" node from the *Matte* node group, and a "*Mix*" node from the *Color* node group. The Mix output will go to a Composite node and a Viewer node. Enable the Backdrop rendering so you can see your adjustments in the background. Connect the nodes as shown above. The difficult part of this set up is adjusting the Keying settings so the green is removed, but none of the desired image. You may have trouble with shadows and glow depending on the quality of the video used.

Creating an output video will be discussed in *Chapter 24: Video Sequence Editing.*
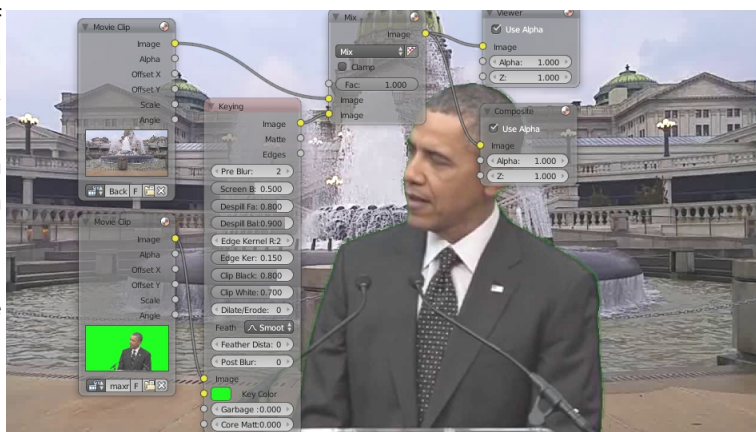
Lighting Types and Settings

When you create a scene in Blender, you start with a few basic elements that will include a camera, but may or may not include a light. Remember that what the camera sees is what will render out as a picture or movie depending on what you tell the program you want as a final output. To get a simple rendered view, press the "**F12**" key. If the picture is black, you do not have a lamp or the lamp settings or placement is incorrect. To exit the render window, press the "***Esc***" key.

In most cases, you will need more than one lamp in order to properly illuminate your scene. Most scenes usually require 3-4 lamps. *Be careful not to use too many lamps!* The different types of lamps available for you to use are as follows:

Point-	Basic Blender Lamp- shines all directions.
Sun-	Provides even angle of light, regardless of placement from objects.
Spot-	Shines a direct angle of light.
Hemi-	A wider light, much like area lights.
Area-	Provides large area lighting (like a classroom). Can be scaled.

In traditional Blender rendering, only spotlights are able to cast shadows. However, with Ray-tracing (discussed in a later chapter) all lamps can cast shadows.

Lamp Settings:

To create a lamp, position the 3D cursor in a desired location and press "**Shift-A**" and select **Lamp, then type**. The lamp will be placed on the screen. You now have several options to select. With the lamp selected, click the **Lamp** button to bring up the adjusting options. Here's what you see:
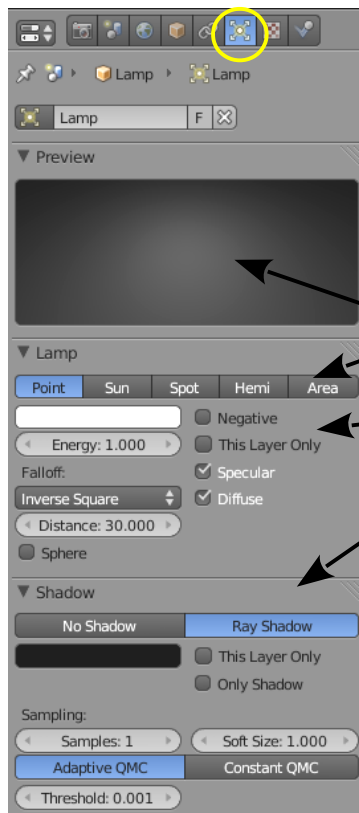
Preview Window: Sample of your lamp settings.

Lamp Type: Can be changed any time. You will get different options depending on the lamp selected.

General Settings: This is where you select the color of the lamp, it's energy (brightness), the distance it shines, and a few other options.

Shadow Options: Shadow style, color and quality. Ray-shadow will be discussed in a later chapter.

These are your basic settings. *Sun* and *Spot* give you some different options. The Sun can actually be used to simulate sky and atmosphere variations. The spotlight will be discussed on the next page.
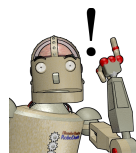
> ***RoboDude Says:*** *Instead of adding too many lights, experiment with the Energy and Distance settings first. In a large scene, the default distance setting may not light the entire scene!*

Spotlight Settings:

Spotlights are unique in that you can simulate a foggy scene with them and cast shadows in the traditional Blender program. Ray-tracing (discussed in a later chapter) can cast shadows for all lamp types, but because of the more complex rendering calculations that need to be performed, renders much slower. If you watch professionally made animations on T.V., you will see that ray-tracing with reflections is not always used because of the rendering time. It is only used when needed. You can do the same thing. Again, we will focus on using the <u>Buffer Shadow</u> settings. <u>Ray-trace</u> shadows will be discussed later. Here are your spotlight settings:

<u>Shadow Type:</u> Buffer is the old style and fastest.

<u>Shadow Color:</u> Adjusts the color of the shadow.

<u>Buffer Type:</u> By holding your mouse over these buttons, it will tell you the benefit of each style (i.e. *Deep* supports transparency and better filtering, but slower).

<u>Filter and Sample:</u> These settings can be used to refine your results, but could add to your render times.

<u>Clip Start and End:</u> Gives a range for calculating shadows. *Represented by a line down through lamp. Keep this line as short as possible to give the best shadowing. New to this release is the <u>Autoclip</u> options to set these for you.*

<u>Spot Shape:</u> Set the Angle Size, Blend (edge softness), and Shape (round or square). You can also give it a haze with the <u>Halo</u> settings and intensity.
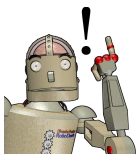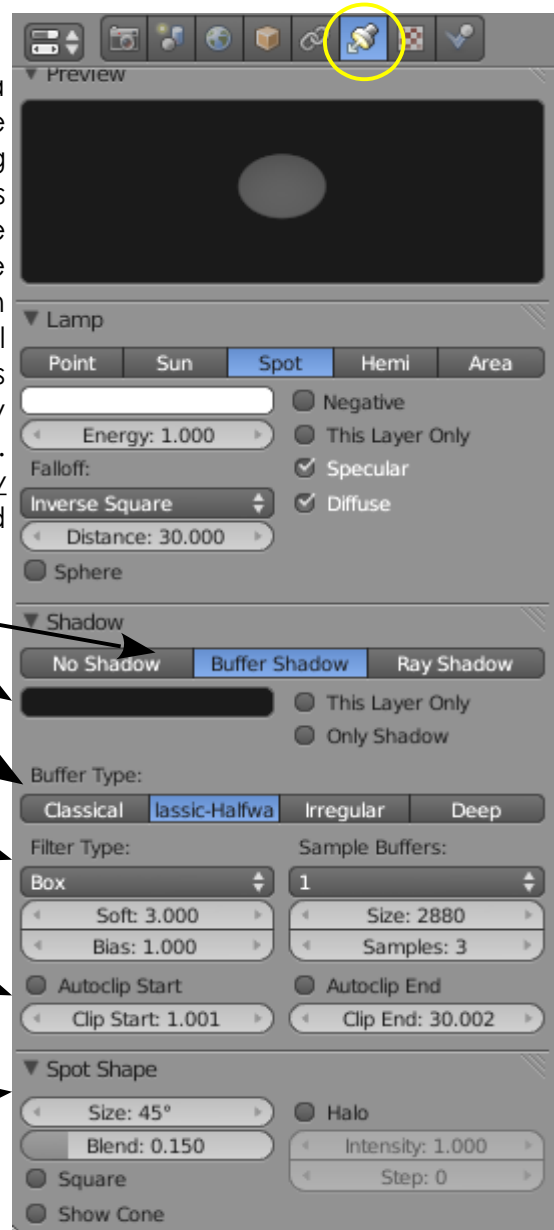
RoboDude Asks: Why can't I see my shadows or why do they look bad? *If you have shadows, but look bad, try a larger <u>Clip Start</u> number to shorten up the area of calculation or adjust the <u>Sample Buffers</u> <u>Size</u> and <u>Samples</u>. If you don't see any shadows at all, you might need to go to the <u>Render</u> buttons and turn on <u>Shadows</u> under <u>Shading</u>.*

Different lights can be used to get different effects. As mentioned before, try not to add too many lights to your scene. It is better to keep it down to 3-4 and play with their locations and setting, rather than flood the scene in light. Think of it in terms of real lighting situations.
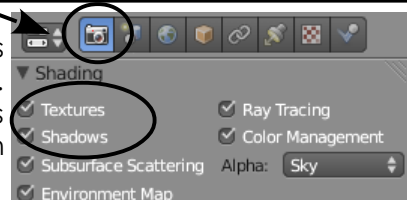
Indirect Lighting

In Cycles, you would use an emission shader to make an object emit light, but in order to achieve this effect in the internal render engine, you will need to use indirect lighting. Indirect light is light that bounces off other objects, like real life. There has always been an *Emit* option in the Blender material settings so an object could glow, even when light wasn't hitting it, but it could never light up things around it. It now can. First, lets set up the material with the <u>*Emit*</u> feature on. For the scene below, I have removed all lamps and the default *World* from the scene. The only reason why the cube glows in the render is due to the *Emit* setting. The plane that it is resting on is not illuminated.

This is what Blender could do in older versions. In order to turn on indirect lighting, I need
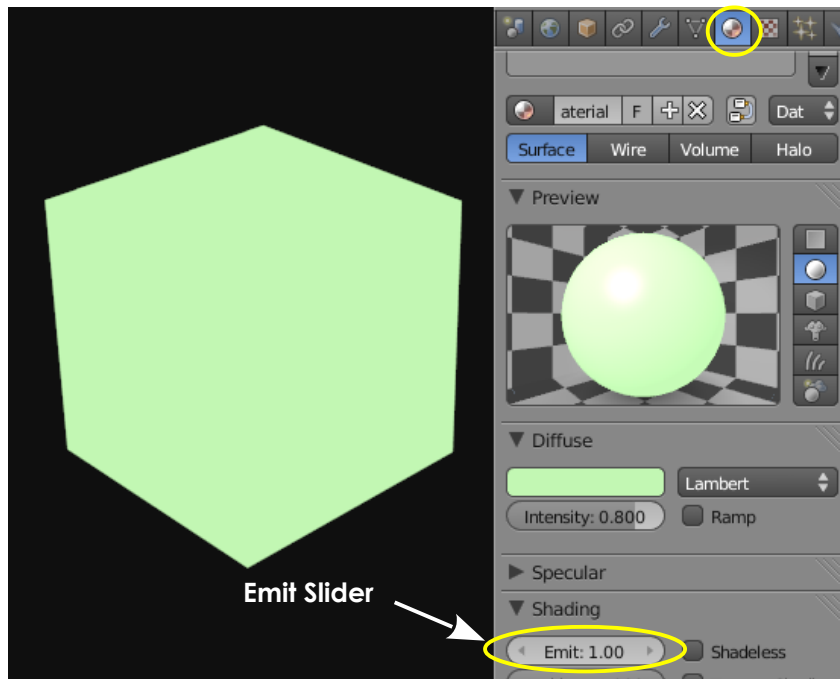
to add a <u>*World*</u> back into the scene. I set the Horizon and Zenith colors to black for added effect. In the World settings, check the box for <u>*Indirect Lighting*</u>. Find the panel labeled <u>*Gather*</u> and turn on <u>*Approximate*</u>. Check and open the panel. You will see a *Factor* (influence) slider and *Bounces*, which will control how many times the light bounces. A rendered scene now shows reflection on the floor plane and a sphere sitting beside the cube, invisible before indirect lighting was applied.

Emit Slider
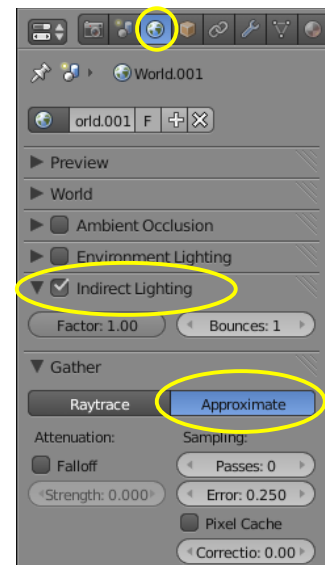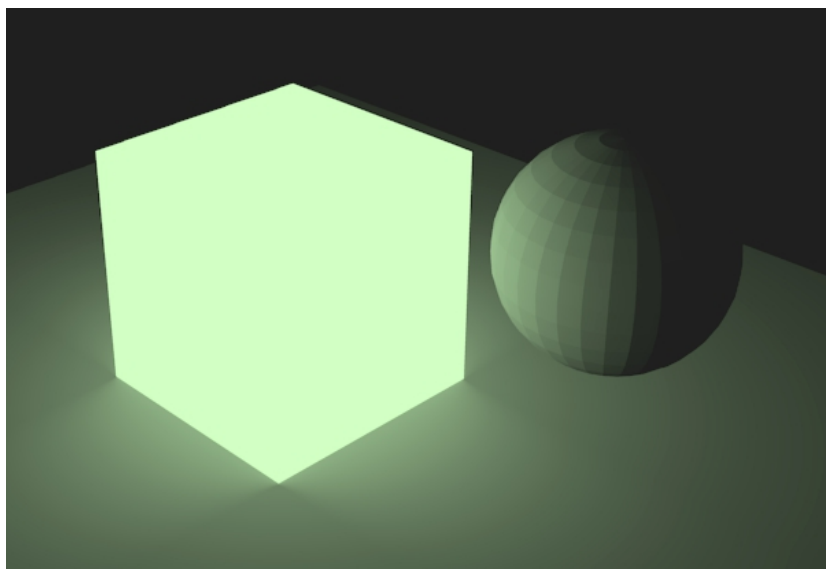
Lighting Up Your Landscape Scene

Internal Renderer: What is a lighthouse scene without a light shining out through the fog? Open your "***Lighthouse Scene***" and place the 3D cursor directly in the middle of the lighthouse where the spotlight should shine. Use your 3 principle views (#1,3,7) to place the cursor in a good location (*the light can always be moved later*). After the cursor is located, check to see if you are in the <u>front view</u> (#1) and add a ***Spot Lamp*** (Shift"A"-*Add-Lamp-Spot*). Rotate the lamp as necessary so it is pointed across your scene and <u>not</u> directly at the camera.
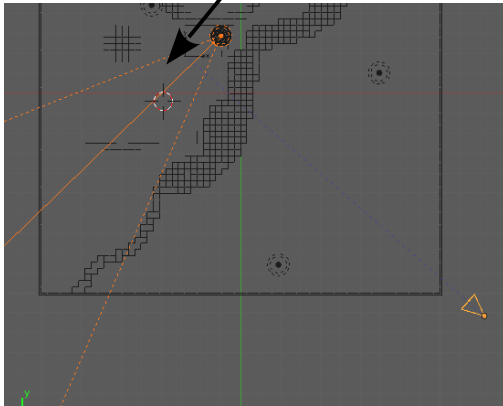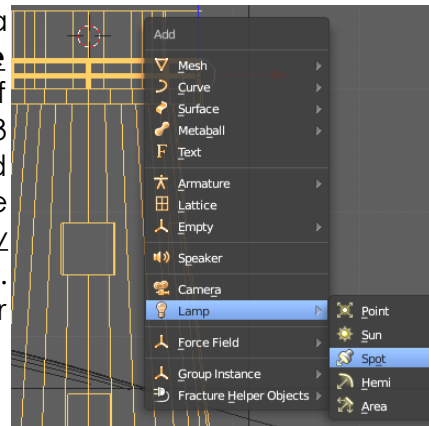
After the lamp is added, go to the <u>Lamp buttons</u> and make sure it is set to **Buffer Shadow**. Adjust the **Energy** to about *1.2*. In the <u>Spot Shape</u> panel, adjust the **Size** slider to about *10*. This will give you a narrow beam that is about 10 degrees wide. Also turn on the **Halo** button. Render an image. Fine tune the spot light with <u>Distance</u> and <u>Energy</u> setting and the <u>Halo Intensity</u> slider.

Your final rendering should look something like the image below. Looks good, but something is missing. There should be something in the middle of the lighthouse emitting that light. We'll do something simple, but effective for that next.

KEEP THIS VERTEX AND MOVE IT TO CENTER

ERASE THESE 3 VERTICES
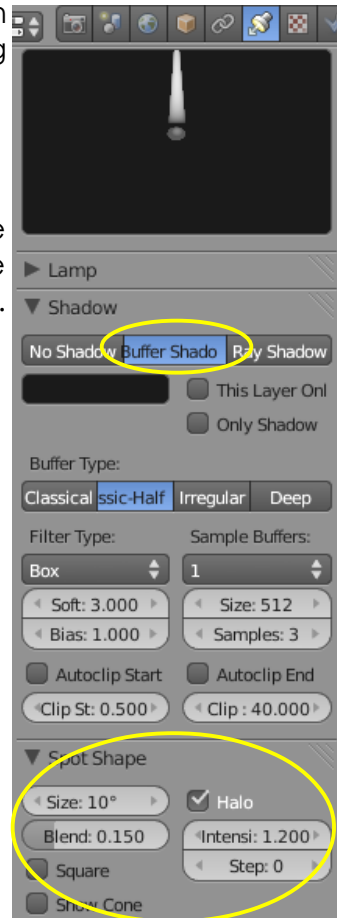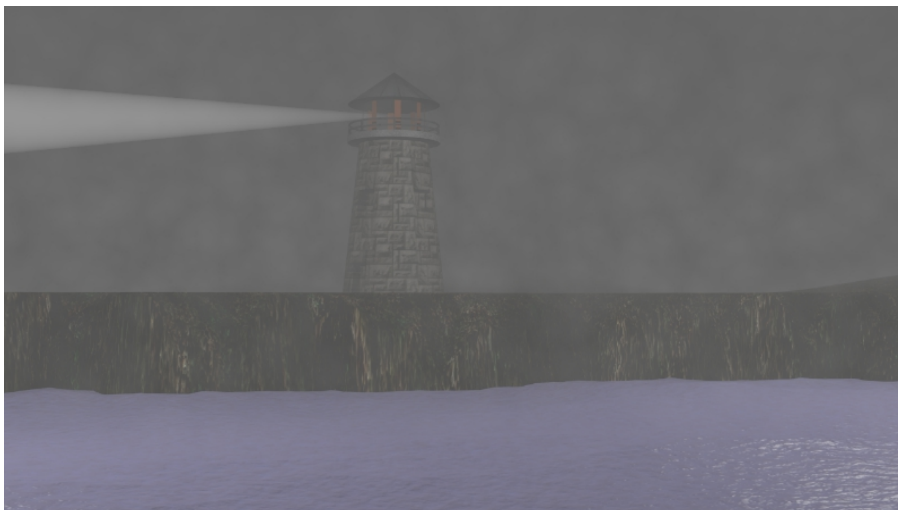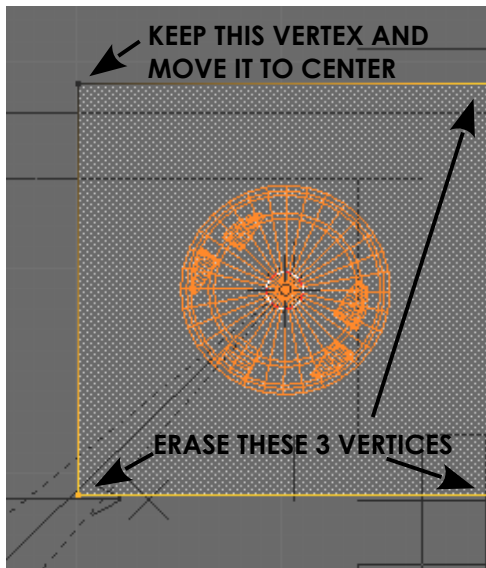
Now it's time to add something in the middle of that lighthouse. Basically, we're going to add a mesh with a single vertex and place a *Halo Material* on it.

Start by making sure the 3D cursor is still in the middle of the lighthouse top. If it isn't, an easy way to get it there is to select the spotlight and hit "**Shift-S**" and select the option "**Cursor to Selected**". This is a great command to use and use often. In the *top view*, add a *plane*. Enter *Edit Mode* (tab) and delete *all* but one vertex. Move that remaining vertex to the center of the lighthouse. After you move the one vertex, exit *Edit Mode* (tab).

Now go to the *Materials* buttons and *Add* a new material. Press the *Halo* button. Here, you will see some Halo settings. Adjust the *Halo Size* (try 1.0 or more), turn on *Rings* and *Star*, and try adding more Rings and Stars. You may want to try adjusting the *Hardness* and *Add* sliders.

Your end result should look something like this with a ring and star in the center of the lighthouse. You may need to darken your world setting a bit to get the best effect.

*** Call the instructor when finished***

P E R F O R M A N C E   T A S K S
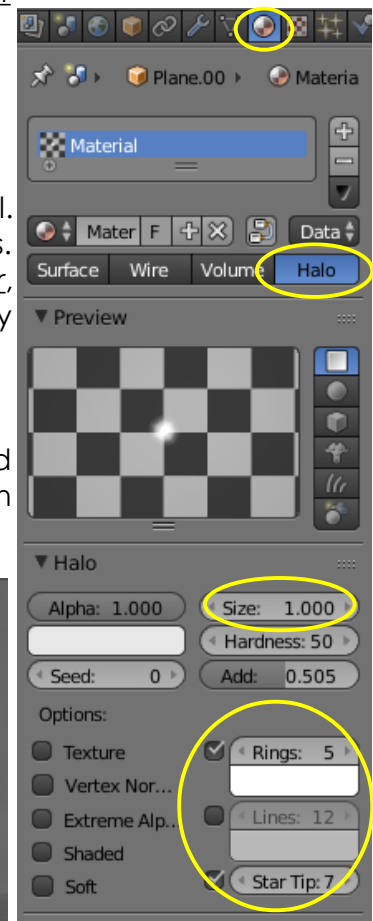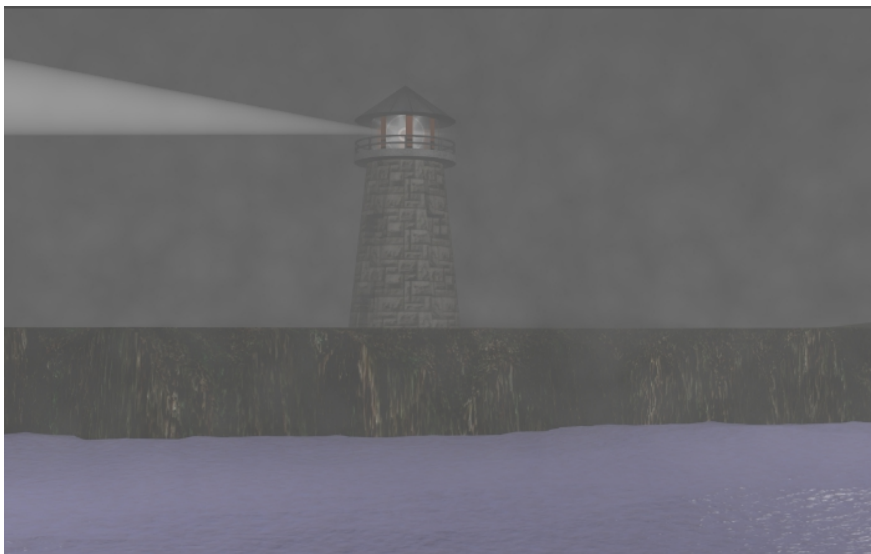
Challenge Task- Cycles Scene & Blur

Cycles Renderer: For this challenge activity, you will be adding an environment and lamp to your lighthouse scene in Cycles, similar to the previous activity.

First, add a misty world to your scene. Refer back to pages 6-7 and 6-7 to add a mist. Try for something like this:
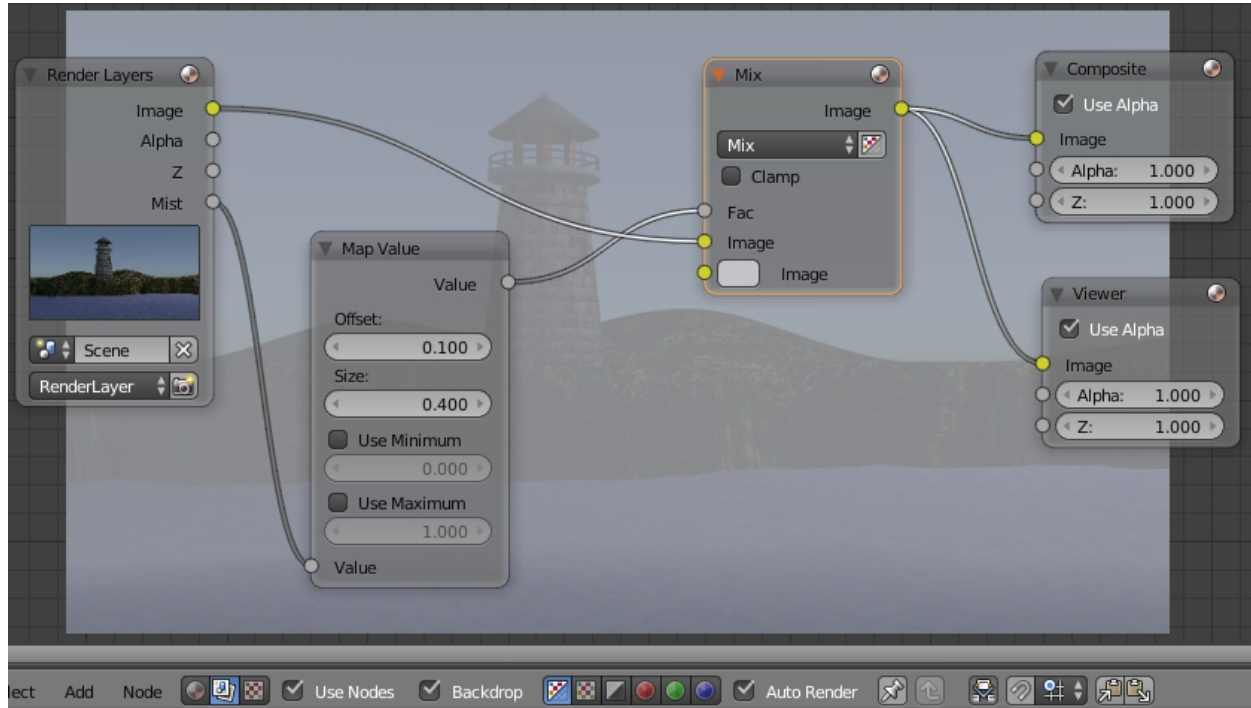
Adjust the color and mist density to your desired results. Our ultimate goal is a "dark and stormy night", so we need to make some lighting adjustments and add the spotlight.

Your first step with lighting is to adjust your current overhead lamp down for a sunset-type effect. Remember that the Cycles lamp setting in under the _Materials_ panel as an emission shader. You will also want to go back to the _World_ properties panel and turn down the _Strength_ of the sky texture for a darker appearance.
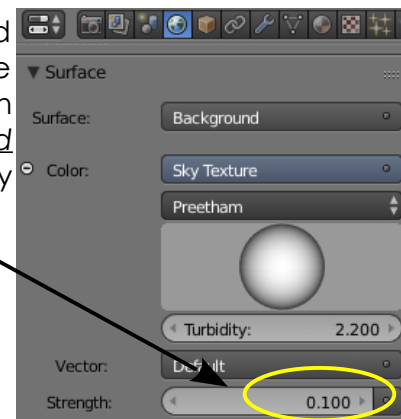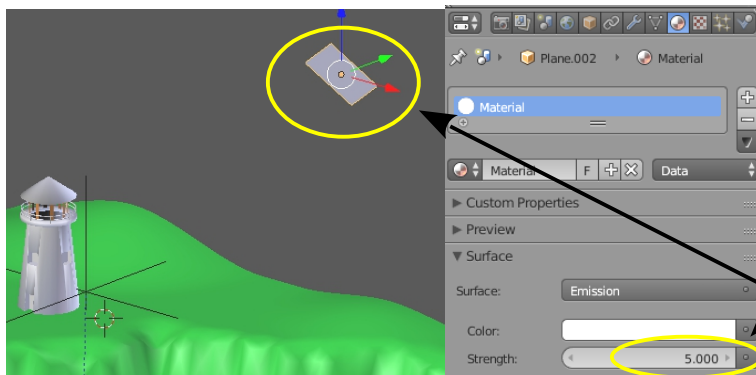
Select the lamp and set the strength in the Materials panel. Render and adjust until you have the desired effects.

It's now time to add the spotlight. There is no easy way to simulate the halo from the cone in Cycles at the time of this writing, but there are several ways to simulate the effect. Here is the easiest method found online:

We will simulate the spotlight with a mesh _Cone_. Create a cone from the *Add-Mesh* menu, enter *Edit* mode, and shape the cone to look like the spotlight used in the previous pages.
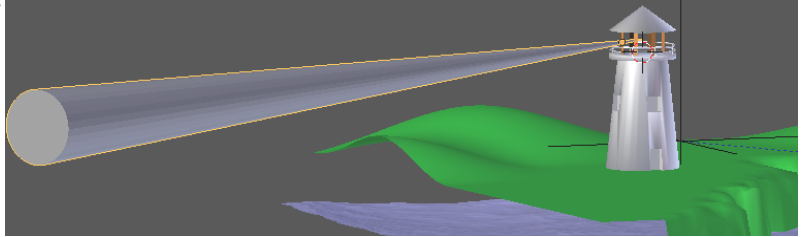
Add the following material nodes to the cone as shown to the right. You will need to adjust the _Emission Strength_ to get a desired effect. The _Volume Scatter_ node creates a mist effect within the cone.
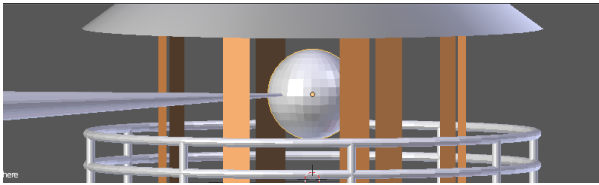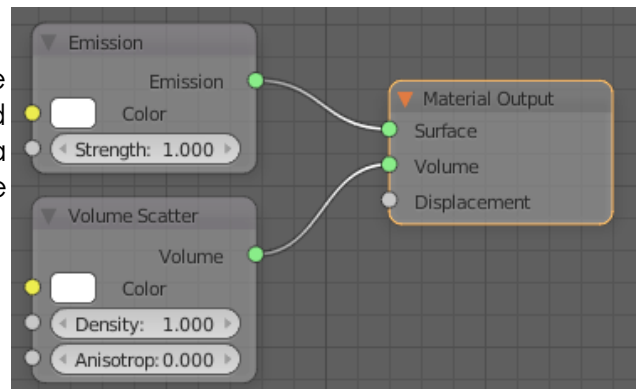
You will also need to add an object, like a sphere or cylinder to simulate the lamp in the lighthouse. Use an Emission shader on this.

You should now have a result similar to the one shown below:

** Call the instructor when finished**

Chapter 7 Reflection and Wrap-up:

Lights, Camera, Not Quite Action!

This chapter's focus was on setting up lights and cameras in your scene. The action part is coming up soon when we discuss animation techniques. Take some time to reflect on your experiences by answering these questions:

1. **Look back at the camera settings found on page 7-1. Many of the features that can be done with real cameras can be simulated using these settings in a virtual world. What happens to a scene when you decrease the focal length? Research the internet to find out where shorter lens lengths can be useful (*called a wide-angle lens*). Explain your results.**

2. **Another feature of real cameras is aperture and is represented by the F-stop number. Research how the aperture works on a camera and why it is useful. Explain your results.**

3. **Explain a situation where it would be useful to use depth-of-field where the foreground and background will be out of focus.**

4. **After completing this chapter, what was your greatest challenge and learning experience and why? Explain.**

Basic Setup Options

The render window is where you set up the output for your scene. Do you want a JPEG picture image or a movie? What size do you want the output to be? Do you want a high quality output or a draft style format? Do you want shadows or Ray-tracing effects? How about Motion Blur? If you're doing a movie, how many frames-per-second do you want the movie to run? Last, but not least, where do you want to save the file? All of these issues are addressed in the **Render Settings**. Obviously, the higher the quality of the output, the slower it will render and the larger the file size will be when finished. *For a review of rendering and animation basic, refer back to pages vii and viii in the manual.* Blender has organized these options into 3 tabs- "**Render**","**Render Layers**" and "**Scene**". Click on the **Render** button to get started.

The Rendering Interface and Settings:

There are many options needing addressed in order to save your work as an image or movie. Some of these feature will be discussed in more detail in later chapters. For now, we are just interested in saving basic images in PNG format and movies as MP4s.

Image/Animation Buttons: Pressing F12 is the same as hitting the Render button. *To make a movie, hit Animation.*

Display: Determine if your render occurs in a viewport or in a new window.

Dimensions: This is where you set the size, frame range, scaling and frame rate of your rendering. If you make an animation and it runs too fast or slow, you can change the mapping and scale the time with Time Remapping. Think of it like scaling time. Presets can also be selected.

Anti-Aliasing: Samples with smooth the edges of objects. Default is 8.

Motion Blur: Used to show blur from fast movement.

Shading: This is where you set what features you want rendered. Turning off what you don't need speeds renders.

Performance: Settings for render performance.

Post Processing: If doing composites or sequences (discussed later) are controlled here.

Metadata: Labeling for frames and movies if needed.

Output: Set file types for outputs and saving locations. You can also set compression quality for images. It's always a good idea to type the file extensions when naming output files. *For movies, there will be encoding options in a panel.*

Encoding: Settings for movie and audio file types for your output.

Bake: Baking certain processes to speed rendering.
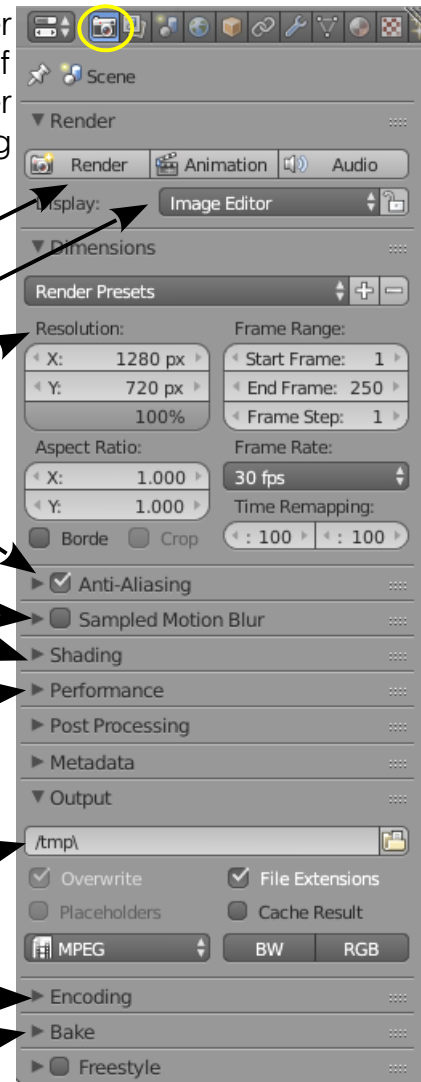
Chapter 8- Render Settings

Render Layer Settings:

The Render Layer settings have been recently moved to their own panel. Objects can be assigned to different layers, making it easy to turn objects on and off, depending on what you wish to render, and work in conjunction with your layer settings that are displayed in the bottom of the 3D window.

Scene: These are the layers that you currently have set to be visible (*matches the active layers displayed at the bottom of the 3D View window*).

Layer: Layers that will render (F12 key). Objects can be in multiple layers in the scene and be set visible, but possibly not visible when rendered. All layers are checked by default.

Include: These are all the other features set to render.

Mask Layer: Objects in a mask layer will not render and actually mask objects behind them. This is a useful feature when doing video tracking projects where you combine real video with 3D modeled elements, discussed in a later chapter. In the example below, the front cube is in layer 1 and set to mask while the back cube is in layer 2, set to render normally. Notice the results when rendered.
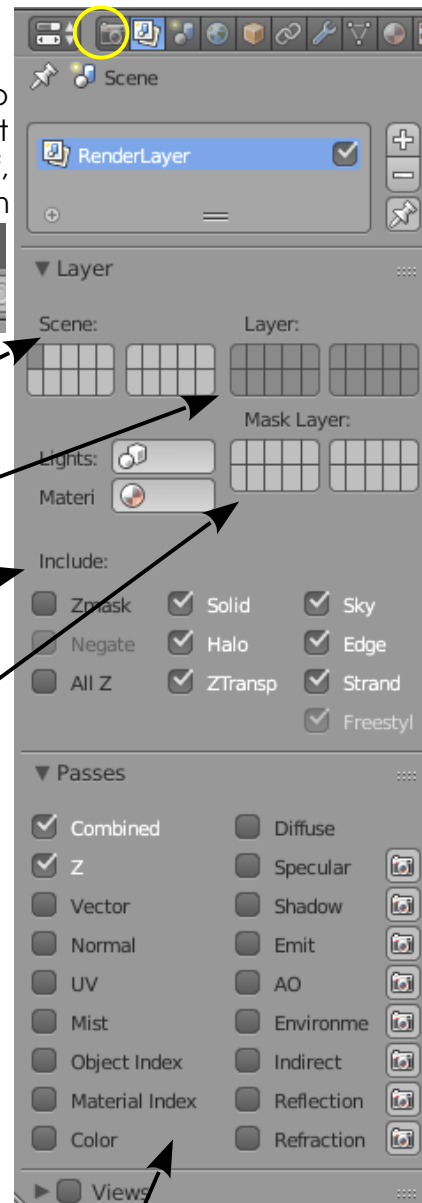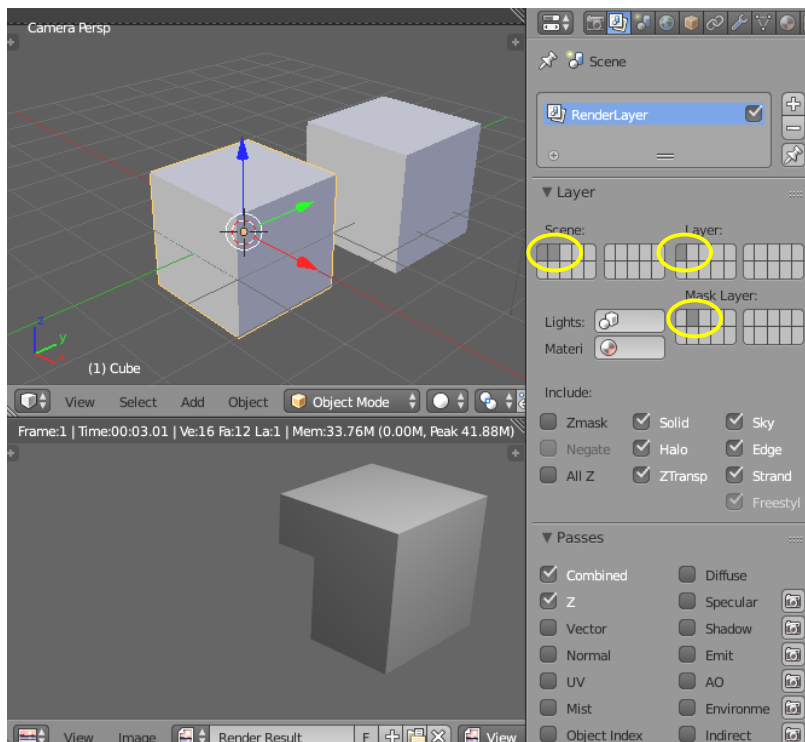
Passes: Set to "Combine" by default to render everything, you can set individual features to render or not render.
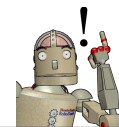
Remember that objects can be moved to different layers by pressing "M"

Scene Settings:

This is where you set up some of the global variables for your entire scene. Many of these options can be set in other places.

Scene: Sets the active camera and any scene that you may want to use as a background. Defaults are typically used.

Units: Sets the units that you use to construct your scene. By default, you are using the "*Blender*" unit, which basically matches a millimeter. There are a variety of basic measurement systems available.

Keying Sets: These are used to record multiple properties at the same time. Typically not set.

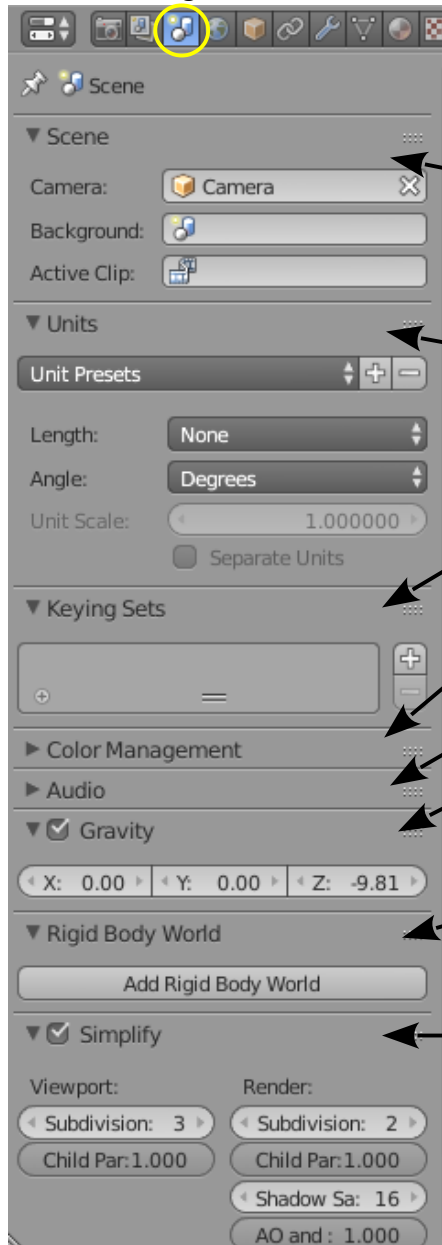*Color Management:* The color configuration system you want to use. Set to RGB by default.

Audio: Global Audio settings for the program.

Gravity: Sets the global gravity of your scene. Gravity is also controlled in other areas of the program that will be discussed in later chapters.

Rigid Body World: These features will be discussed in the real-time and physics chapters.

Simplify: These features are used to limit the quality of various features so your scene does not become to complex accidentally. Typically these features are turned off.

Basic Output Settings:

So now that we have looked at the basic settings of your scene, you now have to decide what your final output will be. Are you rendering an image or a movie? Are you rendering for a standard movie setting like DVD or HD quality? Will it be used as a web page header or button? A sprite for a game or a full page advertisement? You have a lot of options and considerations to consider when deciding what your output settings should be. Refer to the *Rendering and Animation Basics* in the book introduction.

The next page will show you the settings that we use in our lab for quality and speed.

Chapter 8- Render Settings

Rendering Movies and Images

In chapter 10, you will be creating your first computer animation. After you create all of you objects, apply materials and textures, and create your animations, you will be ready to make a movie file of your scene. In past years, we rendered at DVD quality (720 pixels x 480 pixels) at 30 frames-per-second (FPS). We have now switch to HD quality settings (1280 pixels x 720 pixels), 30 FPS with minimal increase in rendering times. You will need to determine your own needs, but these work well. Here are the steps to saving that movie file:

Seven Easy Steps to Create an MPEG Movie File:

Preset Dimensions: *Set this to your desired results. We use* ***HDTV 720p*** *(1280 x 720). Double check the X,Y dimensions and 100% size for final results. For faster test renders, set the percentage lower.*

Frame Range and Rate: *Set the frame range to match your animation length. Set the Frame Rate to the frames-per-second to match your project. US standards are* ***30 fps or 29.97***. *Time Remapping can be used to speed or slow your animation.*

***Anti-Aliasing:*** *Should be checked and set to* ***8*** *for quality renders.*

Additional Features: *Check these features to match your project. Motion Blur will add interesting blur effects related to the speed of an object like a propeller. Shading, Performance, Metadata, and Post Processing default settings are typically all you would need.*

Output: *Click the file folder to name your file and determine your saving location.* <u>*Remember to add the extension after the name*</u>. *In our case, we add* ***.mp4*** *to the end of the file name. This is where you will also set the output file type. Ours is* ***MPEG***.

Encoding: *Set the Format and Codec (file compression) to MPEG-4 for both of these for our settings. You will also want to set the Audio Codec if you have audio in your file output. We typically use* ***MP3***.

Render: *Now that everything is set, go back up to the top the the panel and select* ***Animation***. *The movie should start to render. It is now time to wait until the movie is finished!*

In order to watch your final movie, press ***Ctrl-F11*** *in Blender, or exit Blender and find the file in your drive to watch using any movie player.*
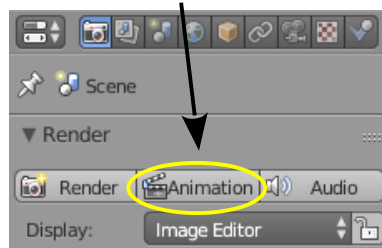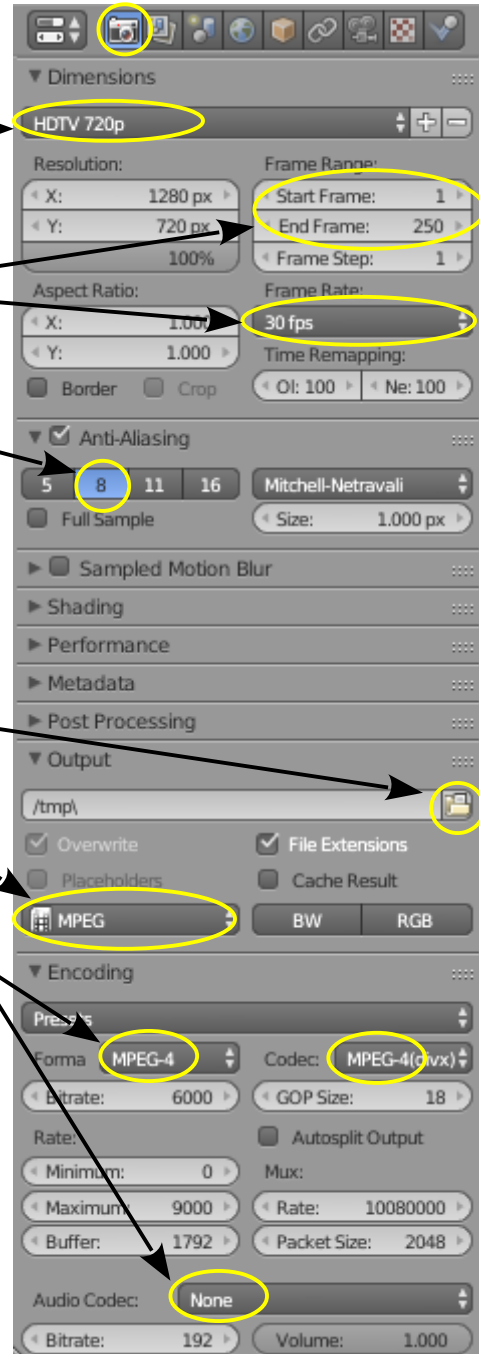
Rendering a PNG or JPEG (.jpg) Image

In order to render a simple PNG or JPEG image, set up all of the options previously discussed. By default, Blender will render a PNG image without changing any of the output settings from MP4. It is important that the file type is set to *JPEG* in the *Render Output* panel if you want a JPEG. Since PNG files can handle transparency and animation, I recommend saving images in PNG format. Press the "*F12*" button or "*Render*" button to bring up the render window. After your image is rendered, Press "*F3*". This will open the file save window. Here is where you give your file a name and set the location. **Remember to type** *.png* **or** *.jpg* **after the name of the file so it saves properly. Windows will not know what to do with the file if the .png or .jpg extension is missing and Blender may not put it on for you.**
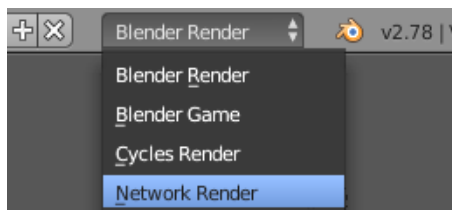
Network Rendering

Network rendering (*also called a Render Farm*) occurs when you use multiple computers to render out your single image or animation. While there are several 3rd party rendering systems our there, Blender has a nice built in network render engine. To enable the network rendering feature, go to the *File* drop down menu and select "*User Preferences*" to enable the **Render:Network Renderer** Add-On. Refer to page 1-3 for a refresher on the User Preferences options. Render farms also allow for multiple projects.

A network renderer works by using several computer that are on the same network to operate together to render your project. There is typically a main computer that houses your project file and servers out parts of the image or animation frames to the other computers. When those computers are finished with their frames, they are sent back to the master computer where more frames are sent back out to the slave computers until the project is finished. Any computer can be used as a slave computer, as long as it has a network connection and enough processing power to be able to render frames.
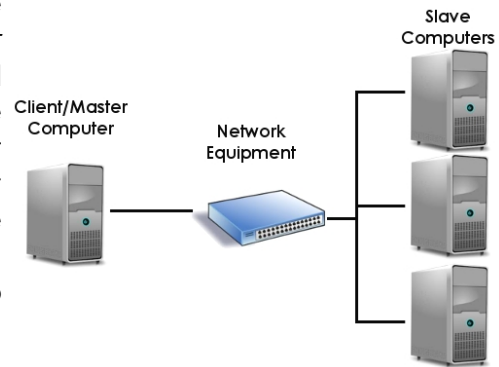
Setting up the Render Farm:

After you have enabled network rendering in the User Preferences, go to the top bar in Blender and switch to *Network Rendering* in the same drop down where you select the internal renderer or Cycles. You will need to do this for every computer you plan to use for rendering the project (*client, master, and slaves*).
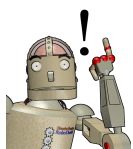
> ***RoboDude Says: I have a lot of computers in my network to manage!***
> *There are many ways to manage your render farm from using a shared keyboard/mouse/monitor to remote desktop access. Access the internet and YouTube for advice to see what may work best for you.*

After you have switched to the Network Renderer, You will need to set up every computer in the network before you add your first project. There are 3 parts to the renderer:

- **Client**- This is the machine that has the actual Blender project on it and where the results will most likely be sent back to when finished.
- **Master-** This is the machine that controls the entire process from taking files from the client and farming out frames to the slave computers. The master also manages all projects from all clients and controls the workflow. You can also set priority to projects.
- **Slave**- These are the computers that are the workhorses. The master serves out frames to the slave machines. When the frames are finished, they send them back to the master machine that sends out more frames to be rendered.

A computer can actually be all 3 parts, but work flow and efficiency will be reduced if the client and master machine must also render frames as a slave. In my small classroom render farm, we use one computer as the client and master machine with several other computers acting as the slave machines.

Master machine setup- The master must be set up before all other machines as all other machines look to the master. Under "*Network Settings*" in the Render properties, select "*Master*" and "*Start Service*". You will also want to set the *Path* where the temporary render files will be save as they are communicated back and forth between computers.

You can set the actual *IP Address* of the machine or leave it as default as we do. The only benefit of setting an address would be when there are more than one master server on a network and you would need to know which one to send a project to. Keep "*Broadcast*" checked. The master is now ready to send and receive projects.
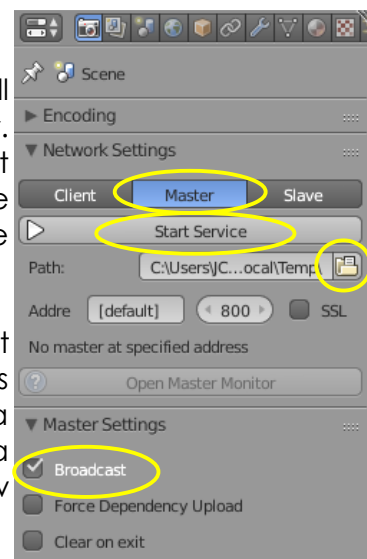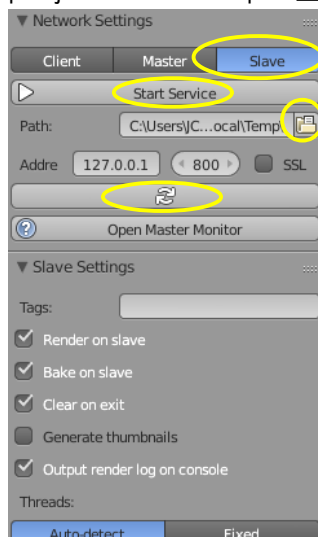
Slave Machine Setup- Now go to a machine that will be a Slave. In the Render properties, select "*Slave*" and then *refresh* the IP Address. After doing this, the IP address of the master machine should display in the address box. You may also want to set the location and folder of the temporary files. Leave all of the checked default settings as shown.

After everything is set, select "*Start Service*". You are now ready to start accepting projects. Set up all slave machines the same way. The next page is designed to use as a quick reference handout for setting up a project to network render.

Setting Up a Client for Network Rendering

1. **Prepare your file.** Before taking your file to the render farm, did you:

   ✓Check the render file settings? *(follow the steps for animating a movie-frame range; HDTV 720p; MPEG 4 encoding; shading settings; mp4 movie)*

   ✓Pack external data? *(File menu-External Data-Pack into .blend file)*

2. **Save Blender file.** Save to the appropriate shared drive folder that can be accessed by the client Blender program. Also, copy any physics folders used.

3. **Launch your file.** Open your file on the client machine in a fresh Blender program. If this machine is also serving as the master machine, make sure you **do not close** the Blender program running as master.

4. **Set the output file.** Just as you do for any movie output, make sure you are saving your final movie to an appropriate folder, with the extension added. (*typically.mp4*)

5. **Go to File menu and Save your file.** The render farm uses your last saved file.

6. **Switch from Blender Render to Network Render** in the top menu bar.

7. **Make the following adjustments, then press "Animation on Network".**
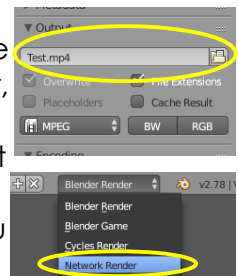
   Client node- *This is what sends your project to the master, then out to the slaves.*

   Server Address- *Press the refresh button to bring up the master server address. Should display an actual number.*

   Chunks- Set to 5- *This setting determines how many frames are sent to each slave at a time. (5 should be the default setting)*

   Animation on network- *This button sends your job out to the network.*
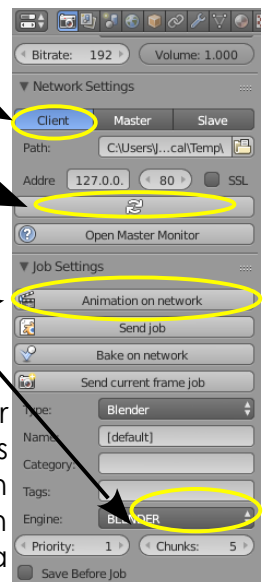
8. **Minimize Blender and Wait (don't close).** You can watch your progress in the browser window if the master monitor has already been launched with other projects. If not, you can press "Open Master Monitor in the render buttons to launch the monitor. All jobs are displayed and their progress with a few setting options. When the file is finished, you can exit your file and copy the movie back to your folder and delete all files and folders you created in the temporary render farm folder folder.

P E R F O R M A N C E   T A S K S

Open your **_Landscape_** file and set up a good view for rendering to a PNG file. Set your render options for the following:

1. **Dimension Presets**- *HDTV 720p (1280 x 720 pixels)*
2. **Turn on Anti-Aliasing-** set to 8 *(set by default, but check)*
3. **Select file output-** Set as PNG, set compression quality to 100%. It is not necessary to name an output file for this activity.
4. **Name your file:** *Landscape Image.jpg*
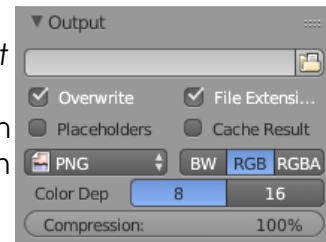
Double check all other settings as per the chapter descriptions, render image (F12) and save the image (F3). *Don't forget to add .png to the end of the file name!* We will soon be using the animation setting so begin to become familiar with those adjustments. We will be using them within the next few exercises. Try setting your image as a desktop background!
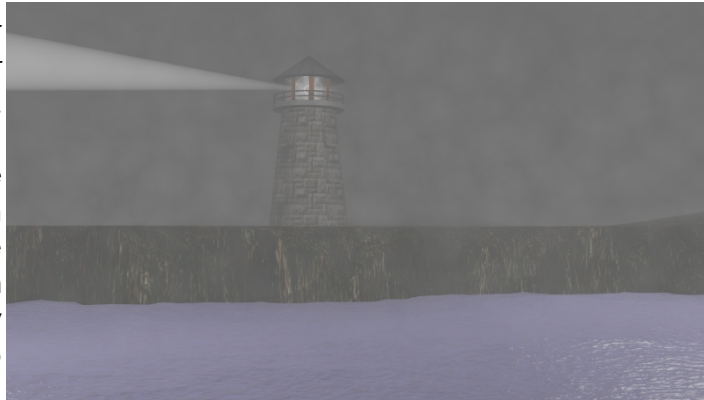
** Call the instructor when finished**
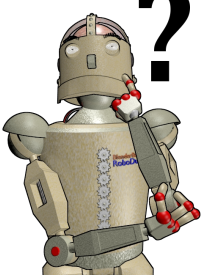
? Chapter 8 Reflection and Wrap-up:

Render Times & Quality

It takes Hollywood a long time to make a 3D animated movie, even with high quality equipment. Take some time to reflect on the following:

1. **Think about the amount of time it takes to render a single picture. This lighthouse scene is simple compared to most professional productions. Try rendering your picture at presets TV NTSC 4:3 (DVD quality); HDTV 720p; and HDTV 1080p. Record your render times. What did you discover? How do you think these times would effect making a feature film? Explain.**

2. **Research the internet. How long does it take to typically make a feature film? How many people work on a project? Explain your findings.**

Ray-tracing is used to produce mirrored and *reflective* surfaces. It is also being used to create transparency and *refraction* (bending of images through transparent surfaces- like a magnifying glass or a lens). With ray-tracing, all Blender lights can cast shadows if you desire. Ray tracing can produce some stunning effect, but can come at a high cost in rendering times. **Use it only where needed**. Don't try to ray-trace everything. The professionals don't even do that. Watch any 3D show on T.V. and you will see it being used selectively. You can get some great shadow and texture effects with Blender's traditional spotlights and material settings at a fraction of the render times.

The ray-tracing features we talk about in this chapter are for the **Internal Render Engine**. Because of the nature of Cycles rendering, ray-tracing is controlled by the shaders we have already talked about. To get ray-tracing to work, you need to go to the *Render* settings and turn on "*Ray Tracing*" in the Shading panel (*should already be checked by default*). Now you are ready to apply some of the ray-tracing features to your objects. *Until you do that you won't see any difference in your renders.*
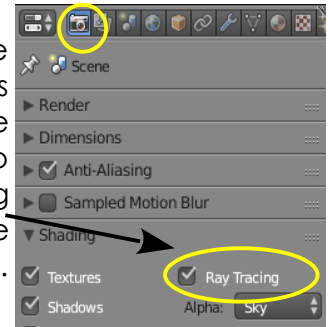
Lighting and Shadows
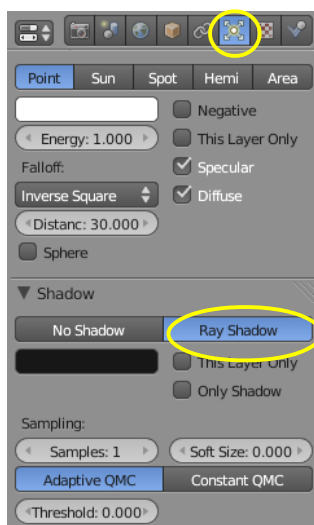
To get a ray shadow for a lamp, select the lamp you want to cast shadows (all types work with ray-tracing), go to the **Lamp** settings, find the "**Ray Shadow**" button and activate it.

When you activate ray shadow, you will see a few setting for most of the lamp types. You will see "*Soft Size*" settings for edge softness and "*Samples*" for improved quality.

You will also see two options called "*Adaptive QMC*" and "*Constant QMC*". These are just ways to generate the shadows with Adaptive being quicker while Constant can give better quality, but slower renders.
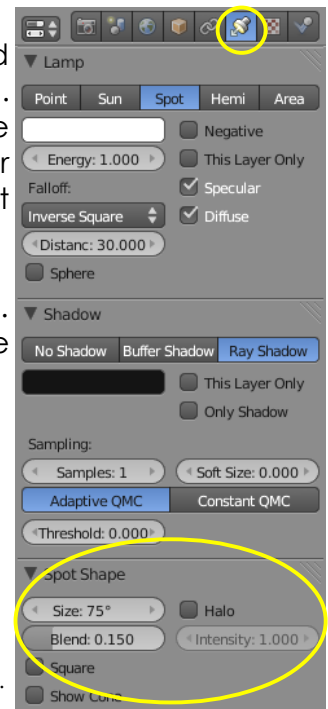
You will notice a few extra setting options for a ray spotlight. *Spotlight Size*, *Spotlight Blend*, and *Halo Intensity* work the same as they do for a buffer shadow spotlight.
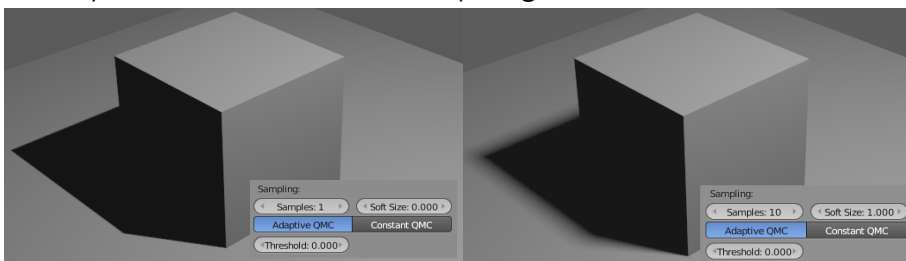
Notice the shadows above. The left image was rendered with Samples at 1 and Soft at 0. The right image was 10 and 1.

Reflection (mirror) and Refraction (transparency)

To create a mirror, or reflective surface on an object, select that object and add a material. You can also add textures to an object and have a mirror surface. In the *Material* buttons, you will find a panel called "***Mirror***". All of the ray-mirror features are found in that panel. Check the "***Mirror***" button and experiment with the reflection settings. The ***Reflect*** slider controls the amount of mirror. A full slider would be a perfect mirror.

For *Transparency*, press the "***Transparency***" button to activate it, select **Raytrace**. Two main adjustments are ***IOR*** (Index of Refraction) is used to create the Lens effect and bends light. ***Fresnel*** is used to control the amount of transparency. There are some other setting that you may feel free to experiment with, but these are the main settings.

Alpha: This transparency setting can also be used with Ray Transparent.

IOR: (Index of Refraction) Controls the amount of distortion.

Depth: If you cannot see through the object properly, Depth needs to be set higher.

Reflect: Controls the amount of mirror. Full reflect will give you the effect of a real mirror or chrome.

Distance and Fade: Controls how much is actually reflected and what it should fade to when it reaches that maximum distance. 0 means no limit.
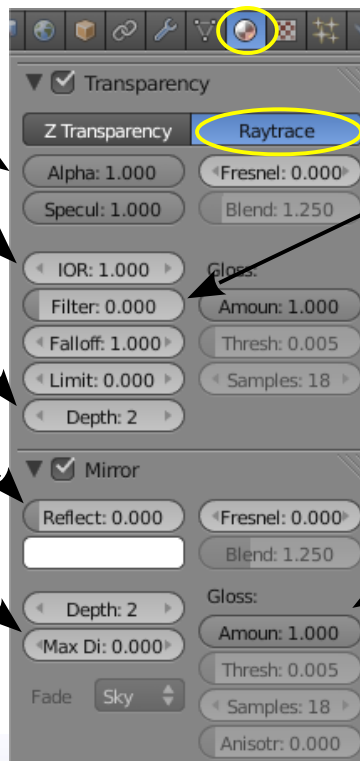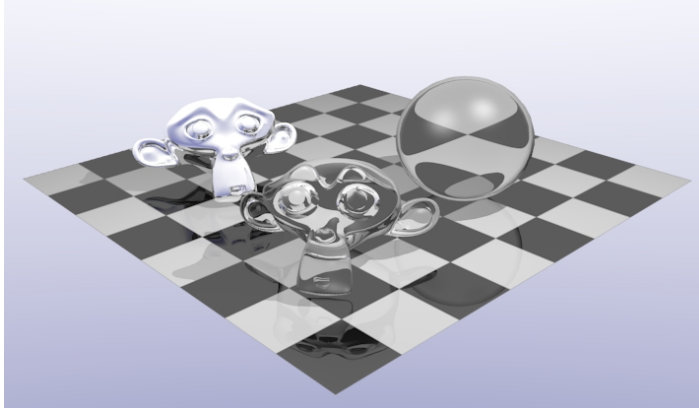

Fresnel: Controls the amount of Ray Trasparency.

Filter/Falloff/Limit: These settings control additional effect with how light passes through an object.

*Fresnel:* In mirror, this causes a fogging effect on the surface.

*Gloss:* These settings control additional effects to the mirror.

The image to the left uses a small amount of ray mirror on the floor and a high ray mirror reflection on the back monkey head to simulate chrome. The front monkey head and sphere are using a high fresnel and IOR setting to simulate glass and distortion.

Since we don't have many objects that would work well with mirror/transparency in our lighthouse scene (except the water, which would create a slow rendering), we will create a new scene for our ray-tracing exercise. Since we have experience using the *Extrude* command from our lighthouse modeling, lets use it to make a drinking glass. Start a new scene and erase the *Cube*. Next, add a <u>Circle</u> mesh in the <u>Top</u> view and check the "<u>Fill</u>" option in the *Tool Shelf*.
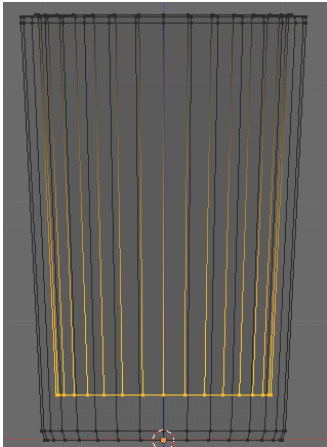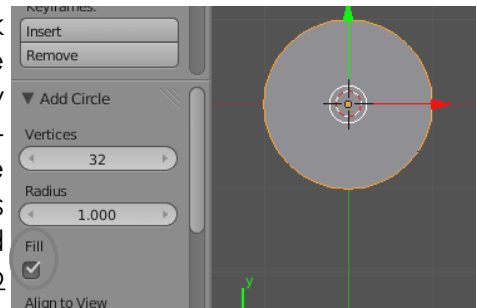

Now switch to a <u>Front</u> view, switch to <u>Edit</u> mode and <u>Wireframe</u> shading. Begin <u>Extruding</u> ("E" key) to shape a simple drinking glass. As you extrude upward, scale the top out a bit to show taper. When you reach the top, extrude back down inside the glass to show wall thickness. When you finish, go back to <u>Object</u> mode, <u>Solid</u> shading, and hit "<u>Smooth</u>" in the *Tool Shelf*.
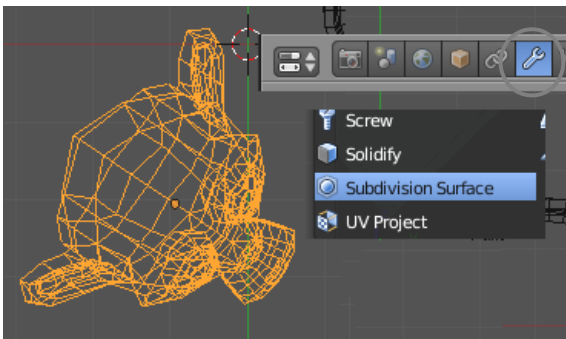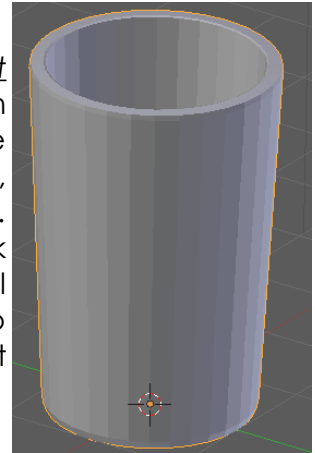
It's now time to add a Plane for the glass to rest on. For fun, let's also add a monkey head to the scene. Set the monkey head <u>Smooth</u> from the *Tool Shelf*, then go to the <u>Modifiers</u> panel and add a <u>Subdivision Surface</u> modifier to shape up the monkey. Sub-Surf adds imaginary rows of verticies to an object in order to improve image quality. Adjust your lights and camera angle to get a scene something like the one shown below:

Now that we have our basic scene, it's time to add materials and texture to our objects. Add an appropriate texture to the floor of your choice and give it a small amount of Ray Mirror as discussed on the previous pages. Also, add a material to the monkey head and take Ray Mirror up to simulate chrome.
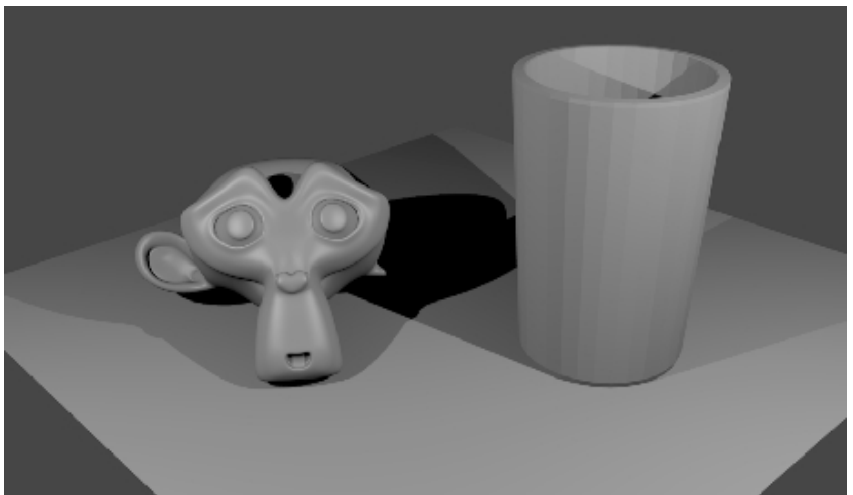
Reflection & Refraction Practice

You should now have a scene that looks something like this. You may notice the tile floor I used looks like it has depth to it. In the Texture settings, I applied a "*Normal*" map to it, like we did with the water in our lighthouse scene. If you need help, refer back to the chapter on materials and textures.
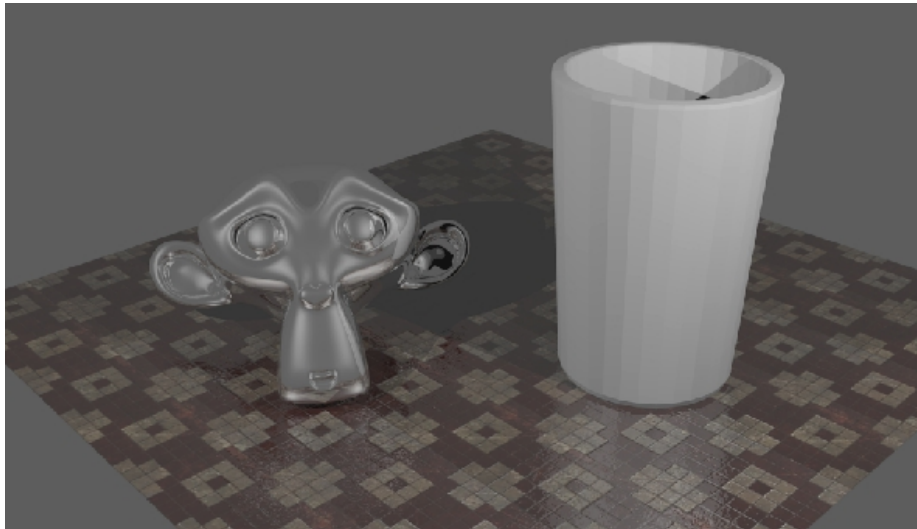
It's now time to place a material on the glass. For the glass, you will want to apply Ray Transparency (fresnel) and a small amount of IOR for refraction. When you render the scene, you will probably notice that you can't see through the entire glass and will look dark. Take the _Depth_ setting up to 5 in the Transparency panel. This will correct the problem. You may also want to apply a _Stucci_ texture to the glass to show waviness. Try taking the _Size_ down to 0.15 and add some _Normal_ as well. You will need to get rid of the pink color. Try setting it to white. Experiment with your setting until you are pleased with the results.

***When finished, render your results and save it as a JPEG image.***
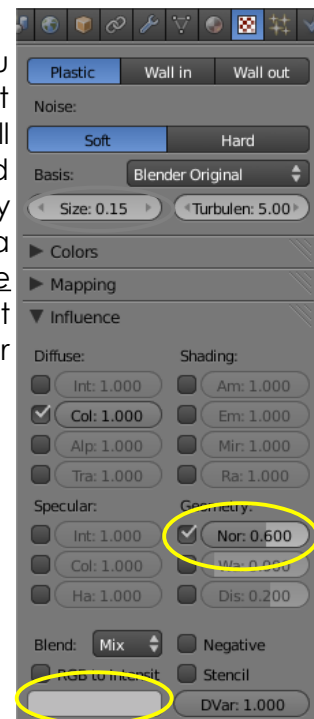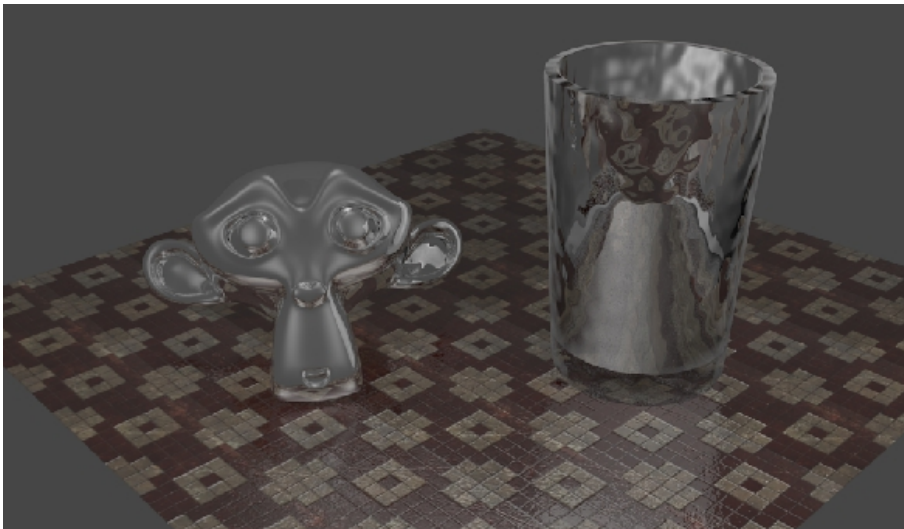
***** Call the instructor when finished*****

Now that you have the basics of reflection and refraction in the Blender internal render engine, it's time to recreate the scene you just made using Cycles for comparison. Remember, the purpose for using Cycles in a scene is to recreate realistic effects.

Your goal is to recreate the previous scene at the highest quality settings possible in the time you have to work and the quality of your machine. Look back at Chapter 4 as a refresher on tweaking your render settings in Cycles. Also, look back at Chapter 5 for material and texture settings for Cycles. Feel free to adjust the world settings as well.
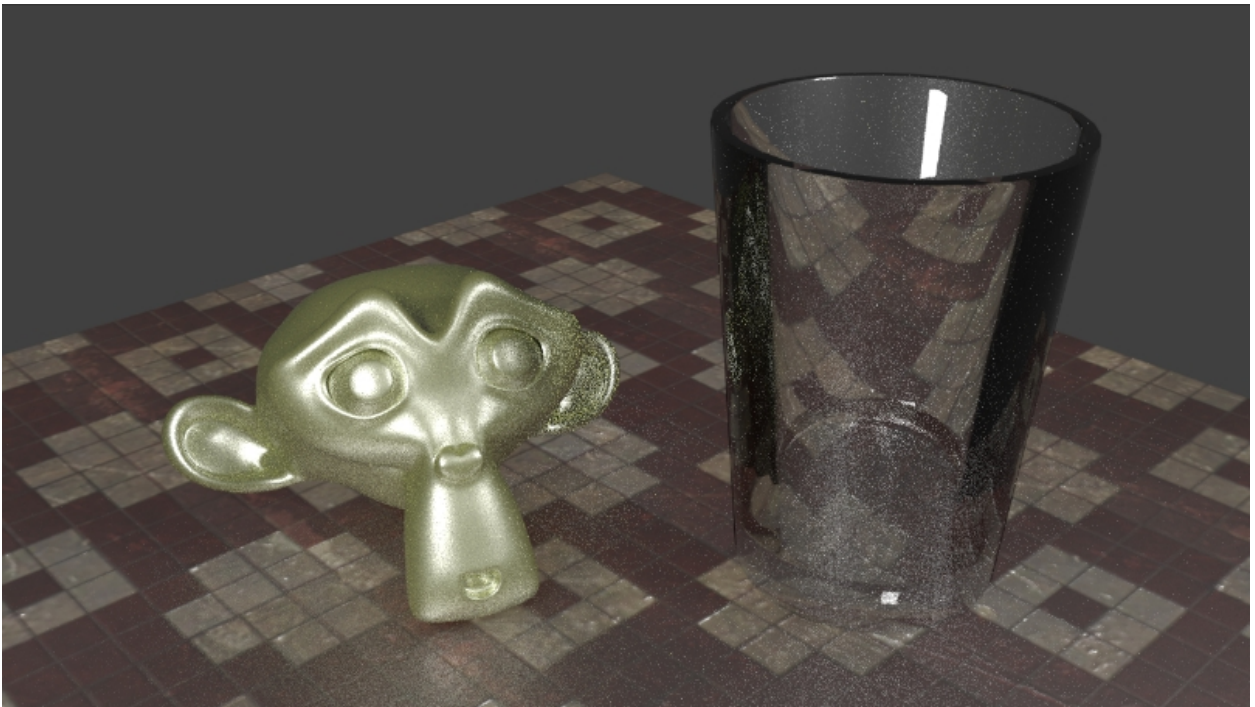
** Call the instructor when finished**

Chapter 9 Reflection and Wrap-up:

Creating Realistic Material Effects

Professionals spend a lot of time studying the look of objects when trying to re-create them in the digital world. Take some time to reflect on your experiences by answering these questions:

1. **Look at the objects around you. Where do you see reflection? You will probably find that many things reflect to some degree- more than you ever noticed before. What have you noticed? Explain.**

2. **As you experimented with reflection in Blender, what happened to an object when reflection was taken up in regards to the object's diffuse color? Did the object lose color? Why did this happen? Explain.**

3. **A chrome car bumper is highly reflective. Chrome can be difficult to simulate in 3D models. Besides reflection, what do you see in chrome? Is it a perfect mirror (100% reflection) or is there something else? Explain.**

4. **Look at some real-world objects that are transparent (windows, clear ball-point pen, paperclip holder, drinking glass, optical glasses, magnifying glass, marble, etc.). Where do you find refraction? How does the amount of refraction relate to the curvature of the object? Explain.**

Basic Key-framing and Auto Key-framing

Now that we know how to make stuff and make it look good, it's time to figure out how to move it around in your scene. If you're familiar with older versions of Blender, this is a HUGE change from the past! What used to be called the **Action Editor** and **IPO** (*Interpolation*) windows are now called the **Dope Sheet** and **Graph Editor** windows. Basically, The Dope Sheet shows your animation keys as points that can be easily copied or moved on a line. The Graph Editor shows your animations as graph curves, where different things can be done with them. This is a big area with lots of things we can do and talk about. Many of the features available will become understandable with practice and by getting beyond the basics. This is a highly developed area in Blender where new features will more than likely be available before this document can ever be printed. For this reason, we will deal with the basics. The first thing we need to do is go back and re-read the section on **Rendering and Animation Basics (pages vi - viii)**.
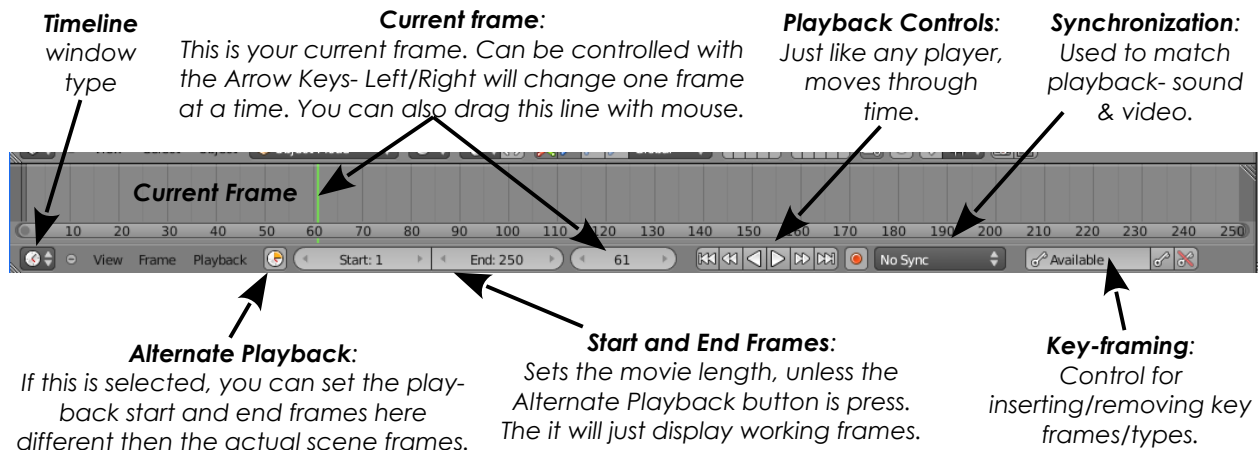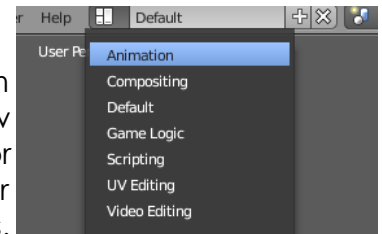
Selecting a preset format will set your frame rate correctly.

After you set up your scene and set the Frames/Second (FPS) in the render button area, consider what you want your "actors" to do and how long they should take to do it. One of the problems that beginner animators experience is making the motions occur in an appropriate time. Remember to look at your frames/second (FPS) when animating and relate it to time. For example, if you want something to take 3 seconds to get from point "A" to point"B" and you are running at 25 fps, you need to complete the animation in a total of 75 frames.
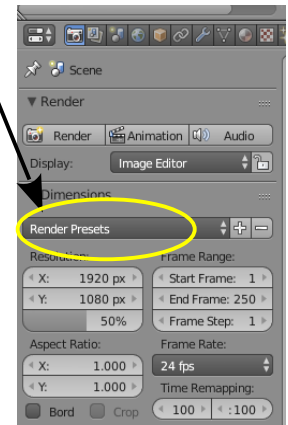
Moving Through Time:

In the picture below, you will find some controls at the bottom of the screen in the *Timeline* window. If the Timeline window isn't visible by default, you can select the *Default* or *Animation* screen in the top toolbar. There are several other ready-made screen layouts that we'll discuss in later chapters.

Timeline window type

Current frame: *This is your current frame. Can be controlled with the Arrow Keys- Left/Right will change one frame at a time. You can also drag this line with mouse.*

Playback Controls: *Just like any player, moves through time.*

Synchronization: *Used to match playback- sound & video.*

Alternate Playback: *If this is selected, you can set the play-back start and end frames here different then the actual scene frames.*

Start and End Frames: *Sets the movie length, unless the Alternate Playback button is press. The it will just display working frames.*

**Key-framing:** *Control for inserting/removing key frames/types.*

Moving, Rotating and Scaling:

These are the 3 basic modifiers to use on an object in animation. When you create key-frames in Blender with these modifiers, Blender will figure out all the **in between** locations on the other frames. To insert a key on an object, go to the frame where you wish to place the key, move, rotate or scale the object, then press the **"I" key** to **"Insert Key"**. Make sure your cursor is in the 3D window when you push the "I" key. The menu to the right pops up. You have 3 main options for now- **Location, Rotation and Scaling** and combinations of these. Select the key option of what you've done to the object. Now, advance to the next frame where you want to put a key (i.e. frame 25 if you want a movement to occur after 1 second), move, rotate or size the object, then press **"I" to insert another key**. *Remember, you can change frames quickly with the arrow keys.*
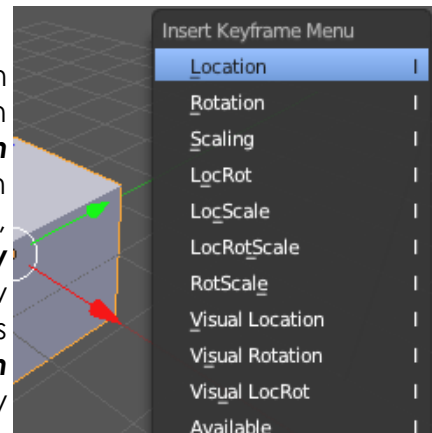
Continue placing keys along your timeline to create your animation. For the most part, location and size keys work flawlessly, **but care needs to be given to rotation keys**. If you try to rotate an object too far in one set of keys, the object may not rotate in the exact direction you want it to. It may rotate oddly. Try small angular steps while animating rotation keys. There are ways to control this better and tools to simplify this process that will be discussed later.
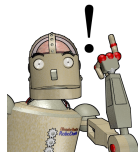
RoboDude Says:
If an object doesn't seem like it rotates properly with animation keys, try pressing Ctrl-A to reset the object's scale and rotation.

Automatic Key-Framing:

Typing "I" to insert keys is the traditional way of entering key frames, but it can become annoying when you have a lot of items to insert key frames for (for example, bones in a skeleton). This is where automatic key framing becomes a useful feature. To turn on automatic key framing, press the *small red circle button* in the *playback* buttons on the *time line* window and select the type of keys to record. This will "*record*" any motion you do on a given frame and insert the necessary key frames needed. Don't forget to set a key on your initial frame. Auto key framing won't do that unless you change something on that frame.
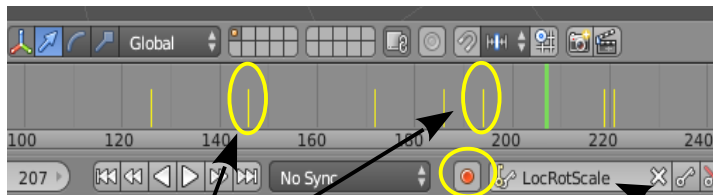
Key Frames:
At any frame where you insert a key, a yellow line will display in the timeline.
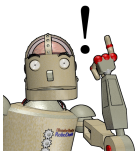
Auto Key Frame Button:
Eliminates the need to press "I" to insert keys.

Auto Key Types:
Select the type of keys you want to automatically record. By setting this, even pressing "I" will automatically add them.

Delete Key Button:
Press this button to delete a key at that frame.

RoboDude Says:
Don't forget to turn off automatic key framing when not needed! You may end up animating things accidentally when you don't want to!

Viewing Your Animation:

There is a simple way to view your animation without having to render out a movie. Take the **current frame number** to the place where you want to start viewing the animation. Place your cursor in the 3D window you wish to view your animation and press the **"Alt" and "A"** keys together. The animation will play. Blender will attempt to display the movie at the correct *frames-per-second*, but may be unable to do so due to scene complexity, computer speed, or image settings (solid or wireframe -Z key).
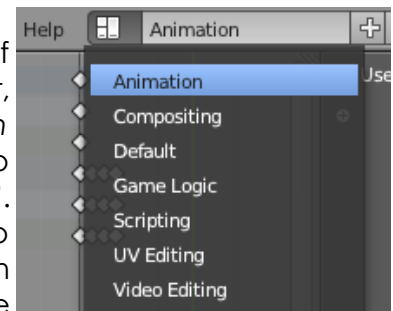
You can also see your animation by pressing the "play" button in the Timeline window. You can also play backwards.
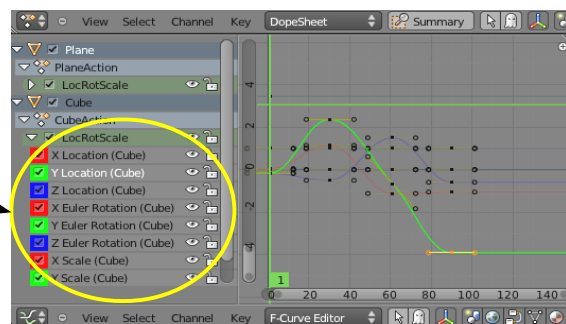
Movement may not be exactly how you planned it. Blender automatically defaults to trying to create a smooth flow through the keys you've place. This can be changed and will be discussed later.

Working with the Graph Editor and Dope Sheet

Animation is difficult to do without some basic knowledge of the **Graph Editor and Dope Sheet**. As mentioned earlier, these used to be called the *IPO (interpolation) and Action Editor* windows. The best way to access these windows is to change your screen layout from "**Default**" to "**Animation**". You will see the 2 windows on the left and it may help to make those windows larger. All objects that have animation keys on them will be displayed in the windows and their data displayed to the right as diamonds (*Dope Sheet*) and curves (*Graph Editor*). You can zoom in/out and pan in this window with the center mouse wheel. Like actual objects, the curves can be edited in an edit and object mode. Older versions of Blender would only show you the curves of a selected object, but 2.6 can display all objects in the scene. At first glance, it can be rather confusing! To simplify your view, you can check/uncheck objects to hide/show their curves. By opening a triangle under an object, you can select individual curves for that object and edit them.
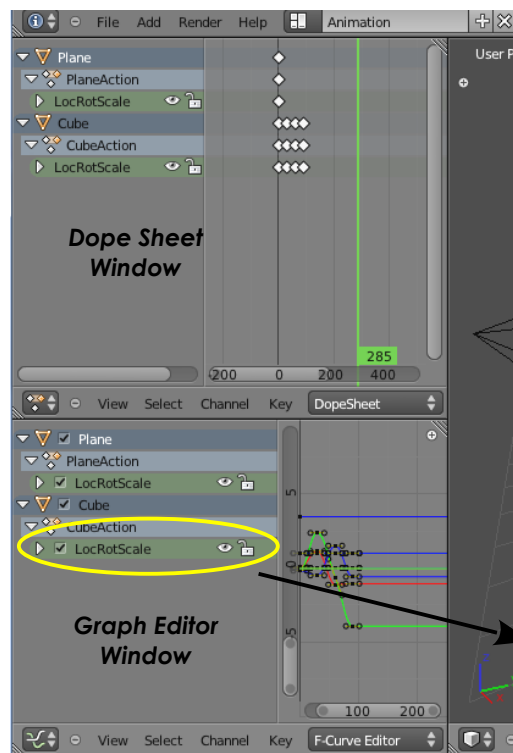
Dope Sheet Window

Graph Editor Window

Chapter 10- Animation Basics

More About the Dope Sheet:

The Dope Sheet shows your animation keys as small diamonds along the time line. This can be very useful when you want to copy keys to other points along the time line or select multiple keys and scale them to slow down an animation. You can select keys the same way you select other objects in Blender- by using the RMB while holding "Shift"; the "B" key to box select, or just RMB a single key. You will notice that when you select a key in the Dope Sheet, the same key is selected in the Graph Editor. You will see many of the same options that are available in the Graph Editor, discussed below.
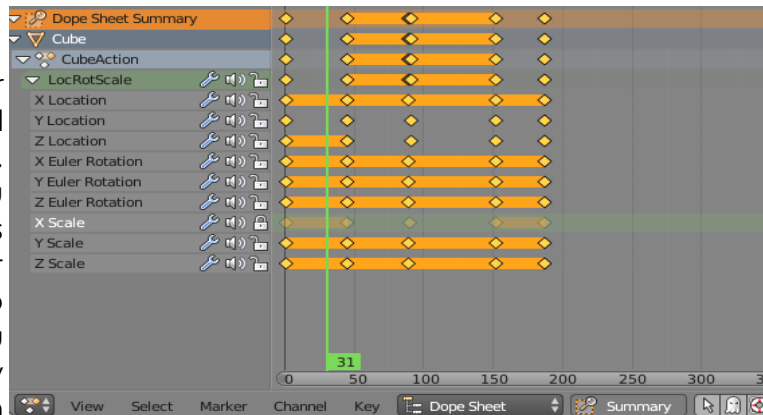
More About the Graph Editor:

In older versions of Blender, you could animate many things, but not everything. The newer versions boast that everything can be animated and so far from what I've seen, this appears to be true. Everything can also be displayed in the Graph Editor, but trying to look at everything at one time is confusing. Below is a short description on how to control the Graph Editor window:
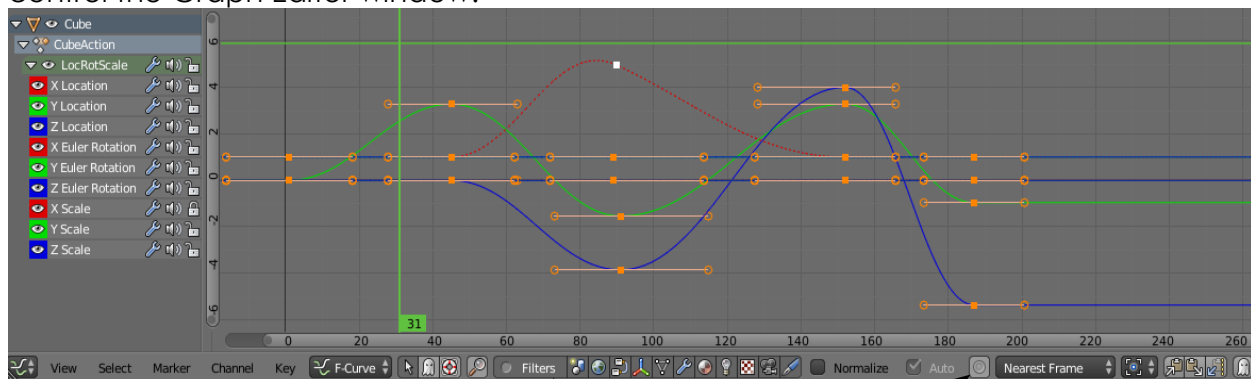
Menus for viewing and options for curves and keys.

Isolate the window to just viewing of selected object (very useful).

Filters- By pressing the Filters button, you can chose which keys to look at to avoid confusion. (i.e. transforms, materials, textures, world, etc.)
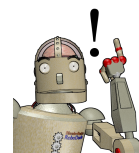
Proportional editing for curves.

Snapping, pivot and copy/paste commands.

Creates a background image of a curve- useful when working on an objects and need to see the curves for another object.

RoboDude Says:
The Graph Editor and Dope Sheet views can be confusing! With practice, it becomes easier to view and maneuver in them.

As mentioned before, when you create an animation for an object, Blender automatically tries to "**smooth**" the path of animation through your key points. You have ways of controlling the results of the path. One way is to click on the path(s) you want to modify in the Graph Editor window and, with the cursor in the Editor window, type "*T*" for type. You can also access these "*Interpolation Modes*" by going to the "*Key*" menu and select "*Interpolation Mode*". You have 3 main options (and others):
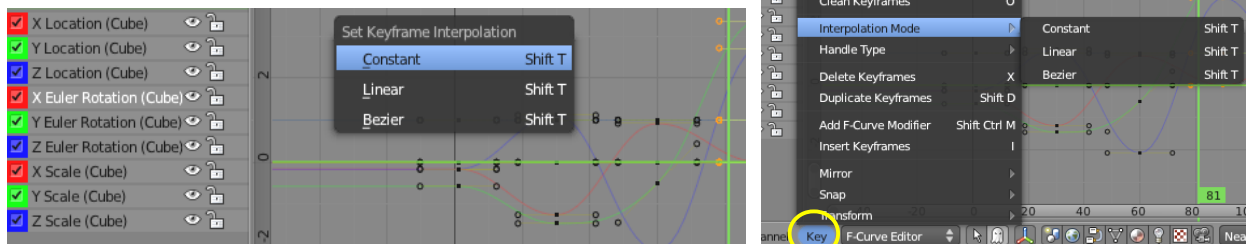
Constant- Gives a square waveform, like turning it on and off. No smooth flow.

Linear- Takes a straight path from point "A" to point "B". Solves problems of animations swinging way out of where you want it to go, but jerky motion at key points
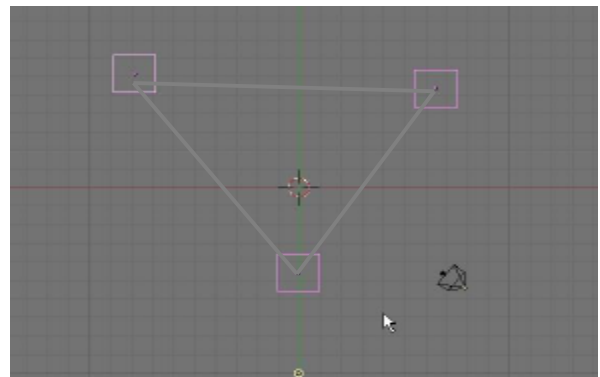
Bezier- The default type which tries to make the motion through the points smooth.

There are other smoothing options available in interpolation mode to experiment with that can change the shape of the curve and effect.
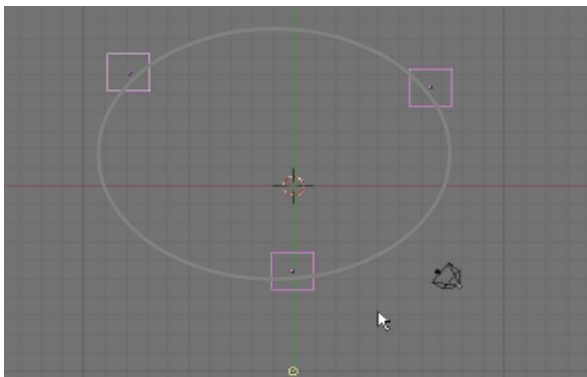

*Animation path of a cube with 3 keys placed at shown locations with **_Bezier_** path type selected. Path is smooth, but curves way out.*


*Animation path of a cube with 3 keys placed at shown locations with **_Linear_** path type selected. Path is straight, but jerky at key points.*

There is another way to keep the bezier type, but control the flow. It requires you to go into the track in **edit** mode (unlocked) and adjust verticies on the graph individually. First, select the track you wish to modify (Loc, Rot, Size- X, Y, or Z) and make sure the track is unlocked (Tab key). **When you do that, each key will be displayed as 3 points**. By grabbing ("*G*" key) an end of the "3-point spline", you can move and size it to get a different flow through that point. This technique requires some skill and practice. Key points can also be moved to different locations using this method (change a key from one frame to another.)
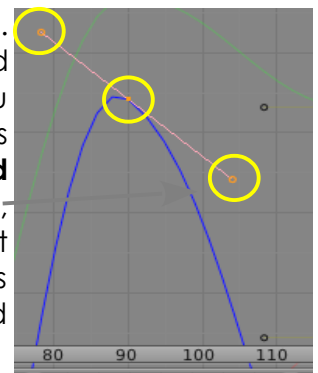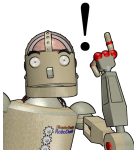
RoboDude Asks: *I messed up my animation. How do I start over?*
If you ever need to start over with an animation, you can erase all the animation tracks in the Graph Editor window and start over. To select all tracks, hit the"A" key once or twice, then the "Delete" key. Be careful that you only have the keys for the selected object!

Modifying Curves in the Graph Editor:

What else can you do in the Graph Editor? There are some simple features that will allow you to set a constant motion or rotation, mirror a curve, apply noise, and set something to cycle through an animation like walking. These are all features that, with a little practice, will save you a lot of work.

Let's first look at an example of making something spin at a constant speed. You first need to set 2 key frames at frame 1 and something like frame 30. Rotate the object 90 degrees between the 2 keys. If you are running at 30 frames-per-second, this would give you a full revolution in 4 seconds, but right now, your animation would stop after 1 second and only spin 90 degrees. In the Graph Editor window, find the rotation track that shows the rotation curve and select it. In my case, it is the Z Rotation curve. By going into the "**Channel**" menu and selecting "**Extrapolation Mode**" you can choose "**Linear Extrapolation**". The curve will extend infinitely. To change the speed, move the key on frame 30. To stop it from spinning at a later frame, move to that frame (say, frame 100) and hit "I" to insert a key-frame on the graph. You can now go back into the "**Extrapolation Mode**" menu and choose "**Constant Extrapolation**". The curve will level out after that frame.
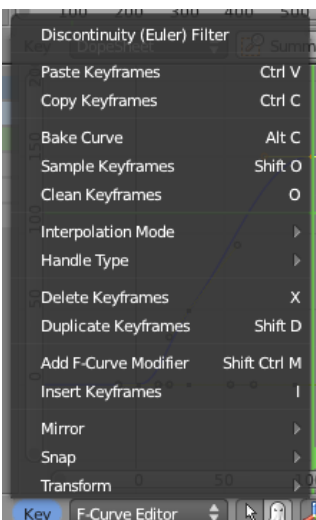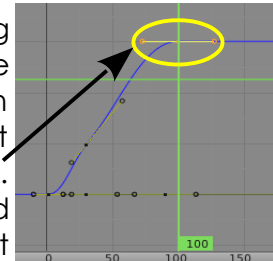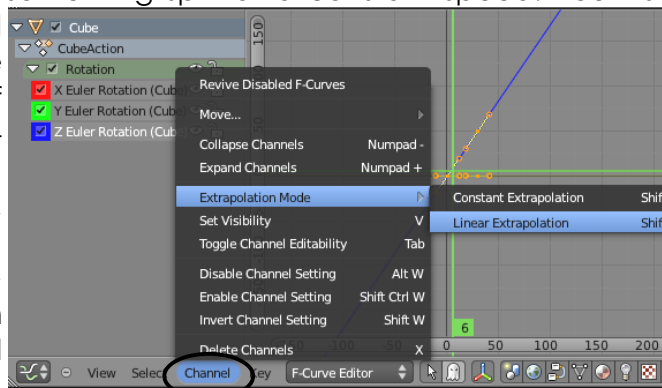
Under the "**Key**" menu, you will find some other useful tools to shape your animations. There is a useful "**Mirror**" option that can flip a curve. This would be useful for objects such as gears and wheels where you need to match the animation of an object, but need to turn in the opposite direction. You will also see a new option in the Key menu called "**Add F-Curve Modifier**". The classic "**Cycles**" option can be found there (useful for repetitive motion like swinging) along with other useful modifies such as "**Noise**" which will give a "jitter" effect to something's motion.
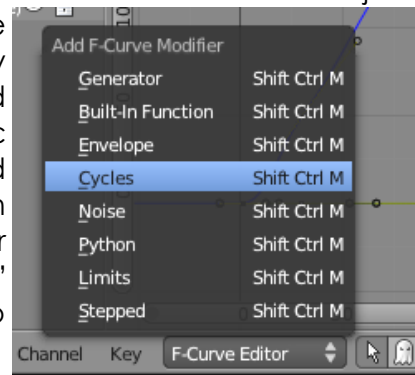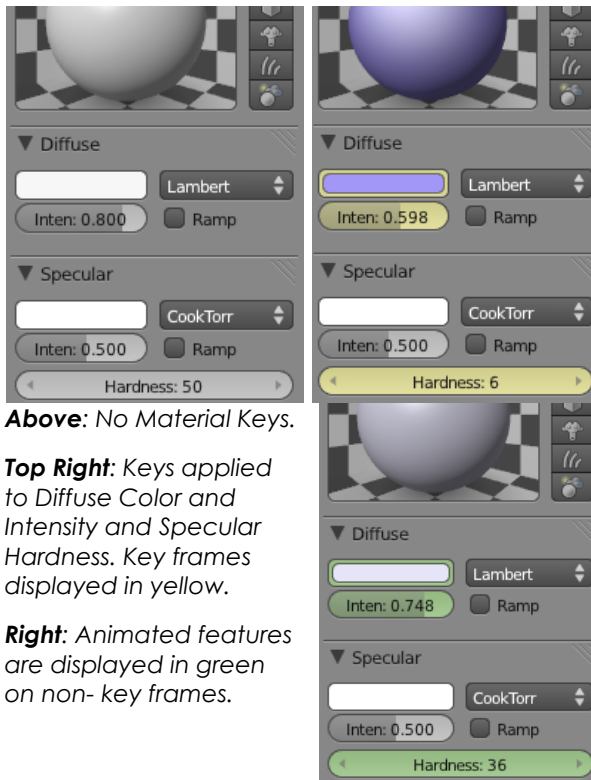
The previous section dealt with basic object animation. Deforming meshes, following paths, creating bone structures (armatures) and creating child-parent relationships will be discussed later. Animation can be a frustrating thing to perfect. Practice!

Animating Materials, Lamps and World Settings (and more)

Earlier we mentioned that everything can be animated in Blender and those animation tracks can be viewed in the Graph Editor. *If you can change a number or a color in a box, it can be animated-* **even in Cycles!** Let's spend some time looking at some of these things. ***The process below works in the Node Editor window as well.***

For my example, I'm changing the material settings on a cube. At frame 1, I'm setting a key frame on the *Diffuse Color* and *Intensity* and *Specular Hardness.* In order to put a key frame on any data block, simply place your cursor over the block and hit "**I**". You will notice the block will turn <u>yellow</u>, indicating that a key frame is present on that setting at that frame number. The block will remain <u>green</u> for all other frames, indicating that the setting is animated. This will even work for check mark boxes.

Above: *No Material Keys.*

Top Right: *Keys applied to Diffuse Color and Intensity and Specular Hardness. Key frames displayed in yellow.*

Right: *Animated features are displayed in green on non- key frames.*

To see the animated effects, you will need to place your cursor in the buttons window and press "Alt-A". The numbers will scroll showing the setting has been animated. You may not be able to see the final effects until a movie is rendered out. This process will work for any window setting.

Notice the Graph Editor to the right. You can open the Material graphs for the cube and see all the settings you applied, provided you have set the buttons at the bottom of the window to display material keys. These keys can be edited the same way discussed on the previous pages.
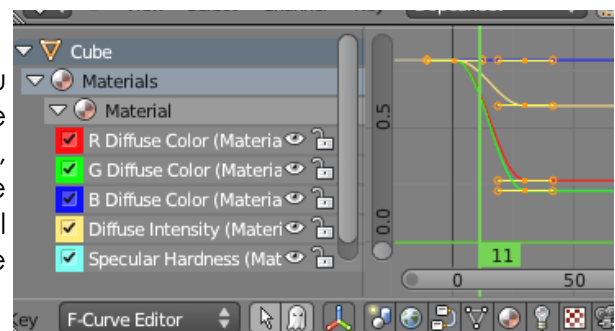
These techniques are useful for animating items such as changing spot lamp size, intensity and color, rolling fog and clouds in the *World* settings, and waves in the *Texture* settings.

> **RoboDude Says:**
> *Remember that you can always undo a bad animation key by using "Ctrl"-Z !*
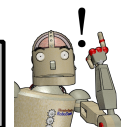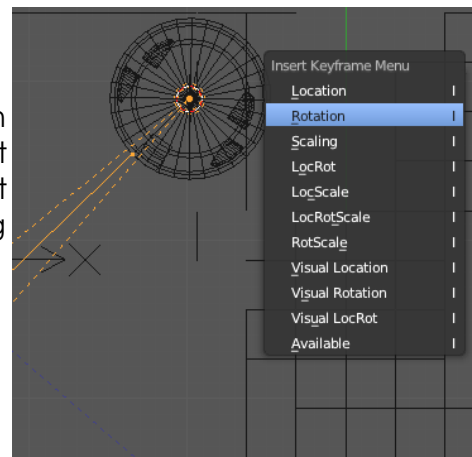
Adding Motion to Your Scene

Open your "**_Landscape Scene_**" file and go to your scene buttons. It's time to animate our "dark and stormy night". We will start by making the correct setting to do a movie. First, review the "*7 Easy Steps to Create an MPEG Movie*" found on page 8-4. Follow those steps and name the output movie file as "**_Stormy Night.mp4_**". Also set the **End** frame to **200**. Our movie will be 200 frames long, or 6.6 seconds at 30 fps. You will also want to make sure Ray Tracing is turned _OFF_. Ray Tracing will slow down your renders and is not necessary for this scene. Change your screen layout from **Default** to **Animation**. Remember, this is found at the top of your screen.
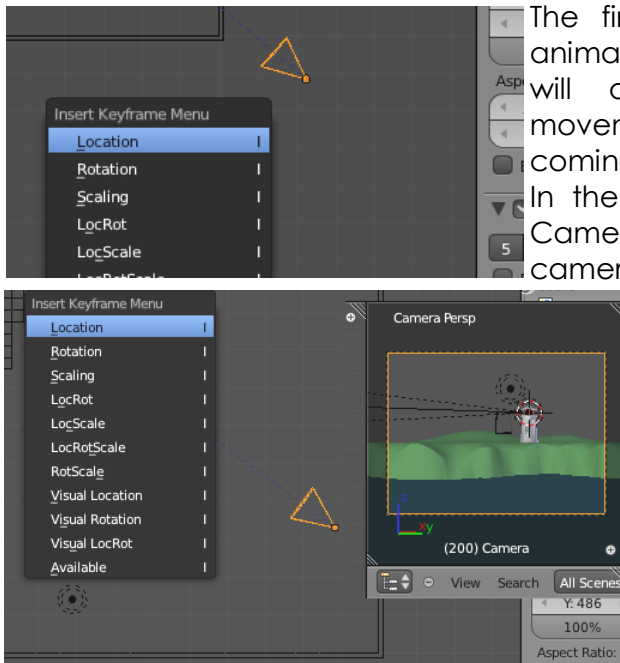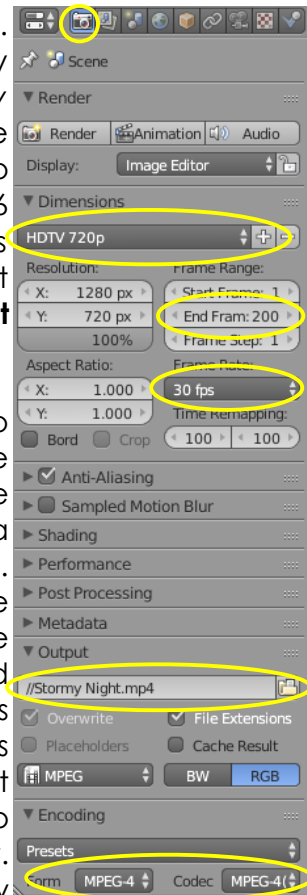
The first thing we plan to animate is the camera. We will do a short, simple movement of the camera coming closer to the shore. In the *top view*, select the Camera. Make sure the camera is at a good location and does not render any edges of your planes. At **_frame 1_**, hit "**I**" to insert a **_Location_** key. Now use your arrow keys to move to **_frame 200_**. Move the camera closer to shore, hit "**I**" to insert another location key.

The motion doesn't need to be much. We don't want the boat moving too fast! Go back to frame 1 and hit **Alt-A** to see your animation. You should see the camera animated. Press **Esc** to stop playing the animation. *Save your file.*

Now we're going to animate the spotlight rotating in the lighthouse. In the *top view*, select the _spotlight_. At _frame 1_, press "**I**" to insert a **_Rot_** (*rotation*) key. It doesn't matter at what angle the spotlight is starting at in the animation.
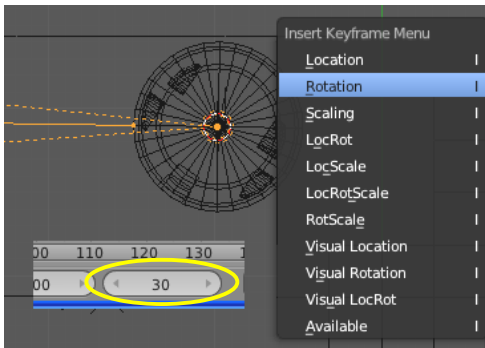
Go to frame **30** (*one second*) and <u>rotate</u> the spotlight <u>45 degrees</u>. To do this, type "**R**" to rotate, then type **45** on the keyboard. Press "**Enter**" or **LMB** click. The lamp will have rotated exactly 45 degrees. If you want the lamp to spin the *opposite* direction, type "-" after the 45. Press "**I**" to insert another <u>Rotation</u> key. Use your left arrow key to go back to frame 1. You should see the lamp spin back to it's original position. Switch to the <u>**Animation**</u> screen.

In order to keep the lamp spinning consistently the entire animation, we could attempt to continue along the time line, inserting keys every 45 degrees and 30 frames, but that would get boring very fast. Instead, we will use an <u>Extend</u> mode in the <u>Curve Editor</u> window. Enlarge the Curve Editor window large enough to work with and turn off the animation tracks for the camera to simplify your view. You

Curve showing rotation change over 30 frames.

Isolate view to selected object

Turn off these tracks

could also press the small arrow button at the bottom of the window to isolate viewing to only the selected object as well. Expand the tracks displaying the rotation keys for the <u>Spotlight</u>. Isolate the track that shows change over time by clicking on it, representing the animation of the lamp over the 30 frames. It will probably be the "**Z Euler Rotation (Spot)**", the blue curve.
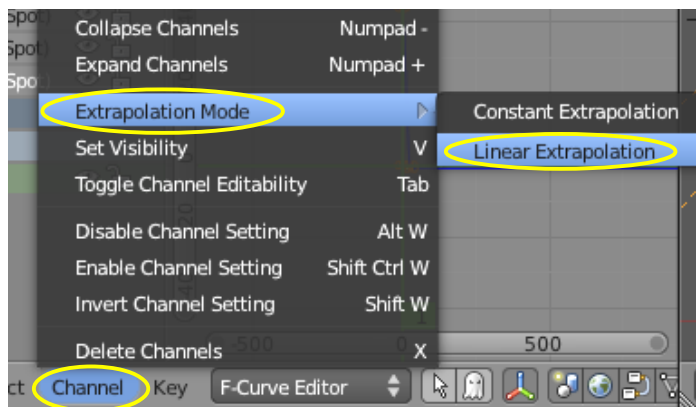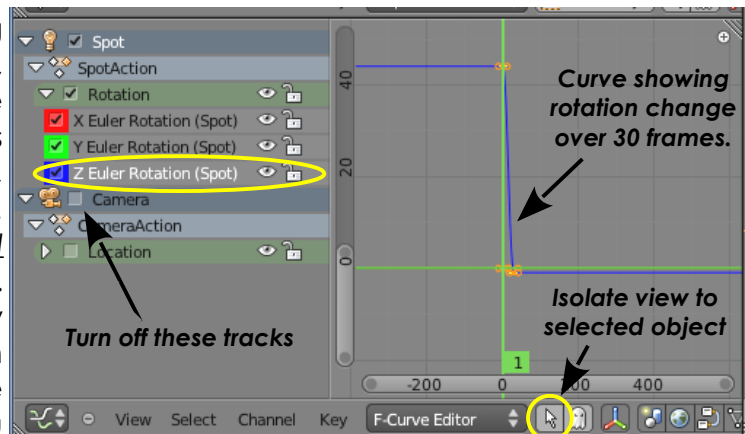
With the curve selected, go to the "**Channel**" menu, "**Extrapolation Mode**", and "**Linear Extrapolation**". The curve should now extend infinitely in both directions. Test your animation by pressing the "**Play**" button in the Timeline, or hitting "**Ctrl-A**". The lamp should spin the entire animation.

The lamp speed should be fine, but if you wish to speed it up or slow it down, you could select the rotation keys at frame 30 in the <u>Dope Sheet</u> and move them to a different location. The curve will adjust.
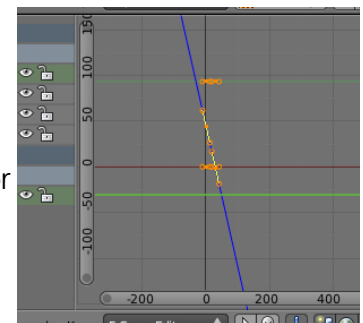
Adding Motion to Your Scene
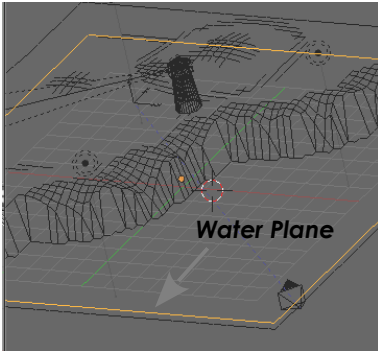
Now it's time to animate the water. We want to create some rolling waves, not too fast or slow. This is a little trial-and-error. I've tried to take some guess work out of the process. To begin, select the **_Water Plane_** and go to your _Texture_ buttons and find the **Offset** settings in the **Mapping** panel. We will animate the **_Offset Z_** number. Because we used a 3D texture and not an image to create the water effect, it can be animated to give the illusion of motion. Remember that we added 2 textures to the water. Right now, we are only animating the 1st texture.

At _frame 1_, place your cursor over the _Offset Z_ number and press the "**I**" key to inset a key frame. The Offset blocks will turn yellow, indicating that a key has been placed on them.
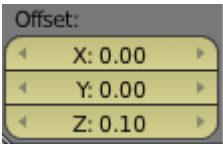
Now advance to **_frame 50_** and change the _Offset Z_ number to **0.1**. This will cause the water to "roll" up slightly. Again, with your cursor over the Offset Z button, press "**I**" to insert a key frame. This will cause the texture offset to roll from frame 1 to 50. Since we can't really hit _Alt-A_ to see the animated texture in the window, we have to wait until we animate a movie to see the speed and effect. If you place your cursor in the properties window area and hit "_Alt-A_" you will see the number changing in the Offset Z block.

It's now time to extend the curve for the texture setting just like we did for the spinning lamp. First, go over to your Graph Editor window and find the material tracks for the plane. Remember that you can isolate your view to just the plane with the arrow button. Select the "Z Offset " curve, go to the "**Channel**" menu, "**Extrapolation Mode**", and "**Linear Extrapolation**". Don't worry if you do not see much of a curve due to the small change we placed on the setting.
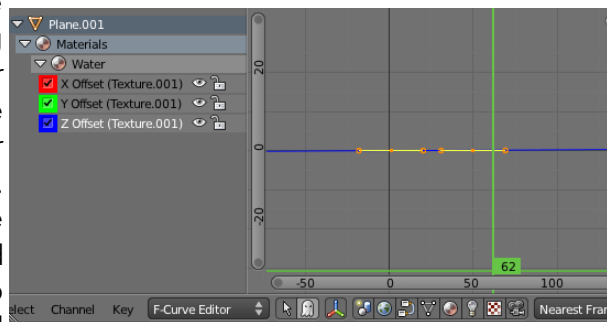
We also want to animate the _Ocean Modifier_ we used on the water plane as well. To do this, go to the Modifier properties panel while the water plane is selected. We will be applying an animation to the _Time_ setting in the panel.
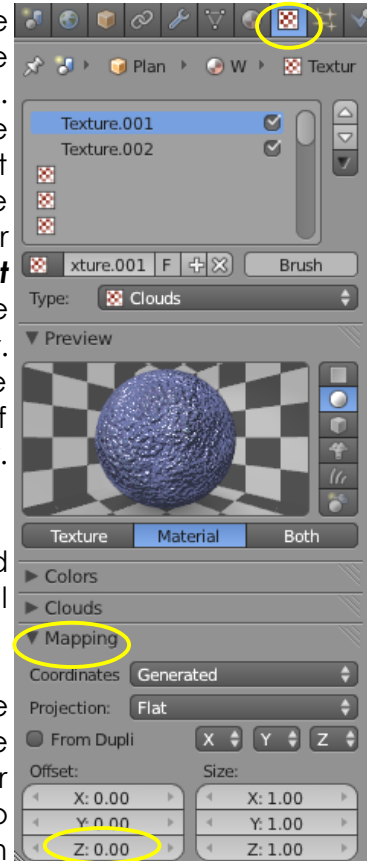
In the Modifier panel, find the <u>*Time*</u> setting. Make sure you are currently on frame <u>1</u> and press "**I**" while over the time setting. Move to frame <u>200</u>, change the <u>*Time*</u> setting to **5.00** and press "**I**" again. At the bottom of the panel, change the <u>End Frame</u> under "<u>*Bake Ocean*</u>" to **200** (the length of our movie). Press the "<u>*Bake Ocean*</u>" button for Blender to calculate the animation of the waves. You will see a progress bar at the top of the screen to let you know when it is finished.

To make the animation run smoothly, go to the <u>*Graph Editor*</u> window and find the <u>*Time (Ocean)*</u> curve. Select it, press "**T**" to change the type to **Linear** to make the animation even.
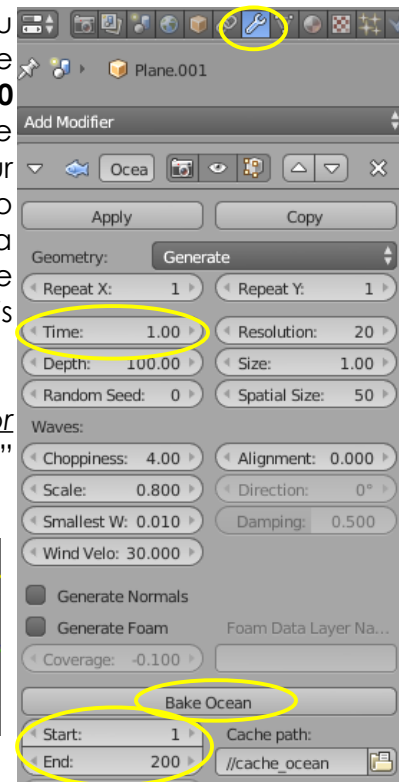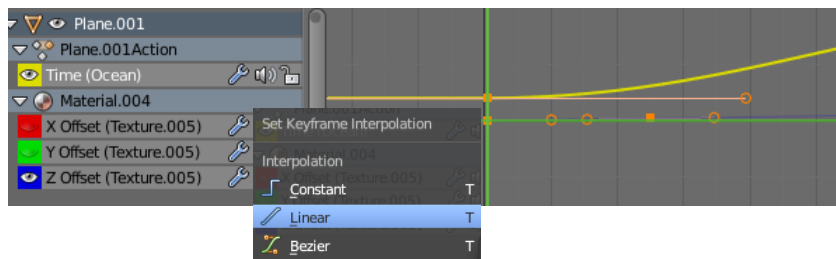
That's it for animation for now. We have animated the camera moving, the lamp spinning and the waves rolling. Later, we will add some rain using particles. You can always change your resolution percentage size to animate faster and check your wave effects. Check your movie setting and press **<u>*Animate*</u>** in the <u>*Scene*</u> buttons. Sit back and wait for your movie to animate.

*** Call the instructor when finished***

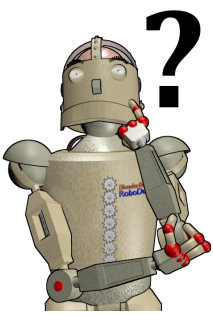## Challenge Task: Logo or Sculpture Animation

Remember the Logo challenge activity in chapter 3? It is now time to create an animation of that scene. Think about other professional logo animations seen in movies and advertising. What can you animate? Try moving the camera and objects, materials, and even the sky. Create reflective materials and other effects. If you did not create a logo, try animating the sculpture you created earlier in chapter 3.
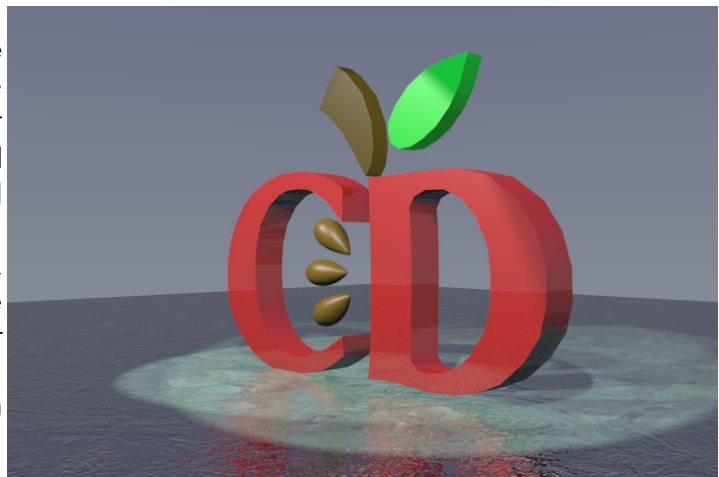
*** Call the instructor when finished***

Chapter 10 Reflection and Wrap-up:

Key-frame Animation Basics

It will be hard to watch an animated movie the same way again now that you know some of the basics of 3D modeling and animation. Key-frame animation is just one way to animate an object. Several more methods will be discussed in later chapters. Take some time to reflect on your experiences by answering these questions:

1. **Inserting key frames in the proper locations can be difficult. Motions can run too fast or slow, appear jerky and inconsistent, or just not move the way you wanted it to move. From your own experiences in this chapter, what did you find the most difficult? Why?**

2. **If you make an entire animation and find out the entire sequence runs too fast, do you need to delete the keys and start over? How can you fix the problem? There are several ways to do this. Several ways can be addressed using information in this chapter, one way can be found in the Render properties panel. Explain 2 ways to correct this problem of speed.**

3. **Key-frame animation is one way to animate a scene. Stop-motion, motion capture, and applied physics are other ways to create animations. Research the internet and briefly explain how at least two of these techniques work.**

We've discussed creating a lot of objects so far, but 3D text can be considered a very important element to add. There are 2 ways to create text for Blender scenes. One way is to use the built-in text generator. The other method is to use an external program to generate the text and import it into Blender. Each method has its benefits and disadvantages. Text made in Blender can be easily changes by entering edit mode ("**Tab**" key) and 3D features can be changed by making adjustments in the edit buttons. Text made in an external program like **Elefont** may give you additional options and different fonts.

Blender 3D Text Settings

To create text in Blender, select the location of your text with the 3D cursor, then press "***Shift-A***" to "***Add***". Select "***Text***". The word "**Text**" appears on the screen in Object mode as a flat, 2D object. To change the text, enter Edit mode ("***Tab***" key). Go to the **Font Settings**. Text can easily be changed by entering edit mode again. Some text settings are similar to many text programs while many are not. Here are your basic options:

Shape Panel:
Set the resolution quality and 3D filling options.

Geometry Panel:
Most common setting- Offset will make the text appear more bold; Extrude gives thickness (depth), bevel angles the edges of the extruded text. You can use a curve object to effect taper and bevel shape.

Font Panel:
This is where you set the font style you wish to use. Blender's font is the default, but can be changed to any *True-Type* font. If using a Windows PC, you can typically find a font folder in the *C:Windows* folder. *Shear* will take the place of the *Italic* setting. *Text on Curve* can be used to shape text.
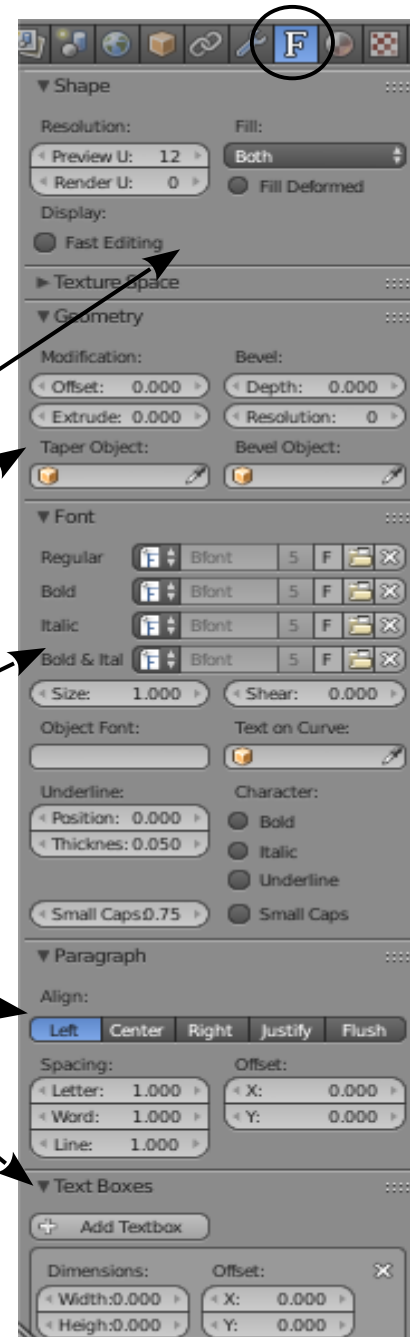
Paragraph Panel:
Typical justification setting and spacing options.

Text Boxes Panel:
By default, text can run on a long as you wish, but you can assign a box to keep text contained.
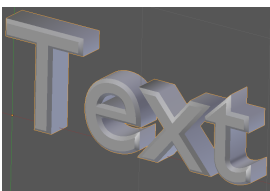
The text to the left has been extruded and a bevel applied. Some fonts will work better than others depending on how the font was created.

RoboDude Asks "Why is my text pointed up?":
Text enters facing up (top view). Remember that you can check the "Align to View" button at the bottom of the tool shelf when you create the text.
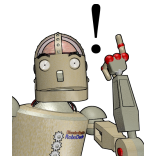
Creating Text on a Curve:

Blender text has the ability to follow a **Curved Path.** In order to create curved text, hit **"Crtl-A"**, select "**Add**", "**Curve**", then "**Path**" (or any other curve shape). Enter *Edit Mode* and shape the curve as desired, then hit **Tab** to exit edit mode.
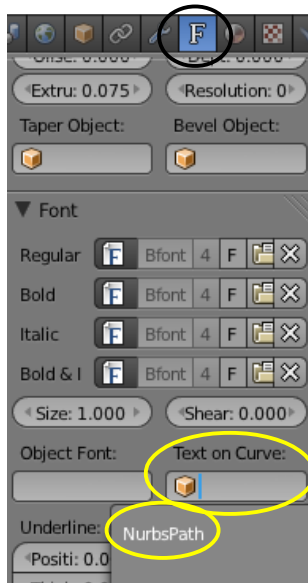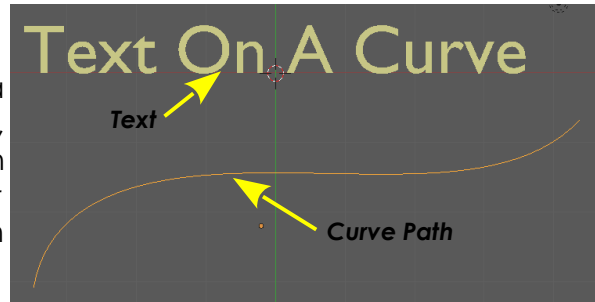
After you create the text and have the text selected, go to the **Font Settings** and find the box "**Text On Curve**". Click in the box to show all available curves that can be used to deform the text. The text will take the shape of the curve. You may need to change the spacing of the text so it flows properly.
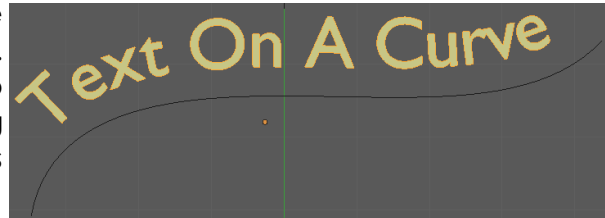
Other curve objects can be used as well to shape the text. So you don't accidentally erase the curve while you work, place the curve in an unused layer (M key).
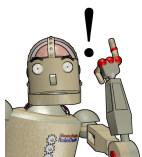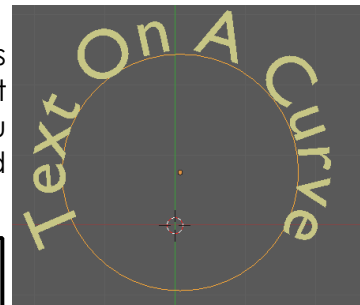
RoboDude Says:
When extruding text for normal titles and labels, be careful not to extrude the text too thick. It may effect how well the text can be read.

Converting Text to a Mesh
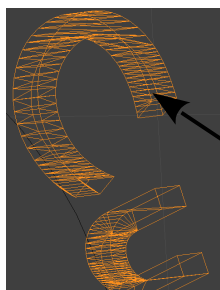
At times you may need to convert text into a mesh for certain purposes (i.e. using a Build or Particle Effect). To convert text into a mesh, press "**Alt-C**" to select **"Mesh from Curve/Surf/Text"**. In edit mode, the text will now display with vertices.
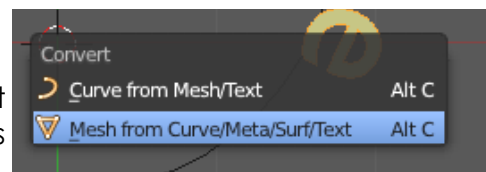
Occasionally, you may feel limited with Blender text. In these cases, you may wish to use an external 3D text program like **Elefont** which saves files in standard DXF format, then import them into your Blender file.

Create a new Blender scene and set up the views any way you wish. You will be creating a company logo of your choice with text. Keep it simple and utilize meshes, textures, lighting effects and ray-tracing to enhance your scene.

When you finish setting up your scene, render a JPEG image and save it to your directory.

Note: The text you see in the scene below was placed on a Bezier Circle Curve. If you leave the circle in the scene it will render faced. The text was converted into a mesh, then the curve deleted. The water was created the same way we did the water in the lighthouse scene (with much less Normal) with ray mirror added. The wall also had a normal applied to give the brick texture some relief.
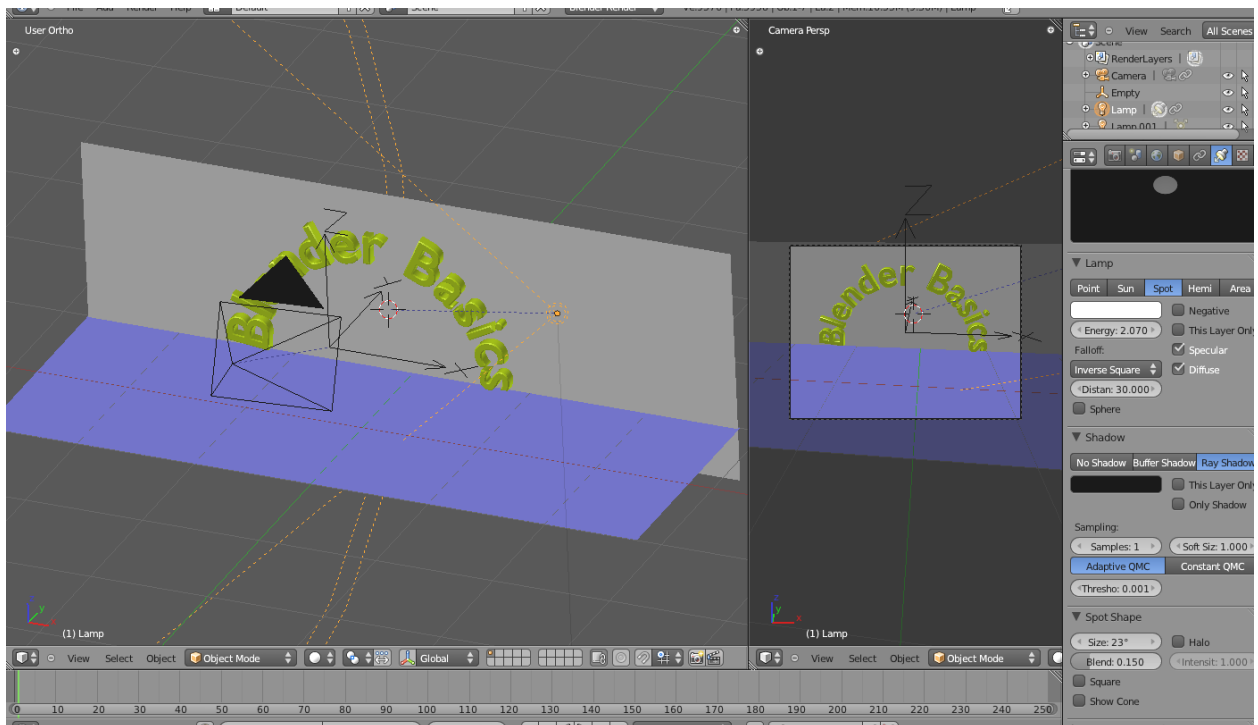
** Call the instructor when finished**

Production Logo

At the end of this book, you will create a movie of all of your work. Just like a professional movie, you will display a short animation of your very own production logo at the beginning of this movie. Create an 8-10 second long animation of your own personal production logo. For inspirational research, look at several popular movie company logos to see how some effects could be done in Blender. Some are as simple as animated text and lighting effects to space scenes. Render your movie using your class-determined render settings and formats.
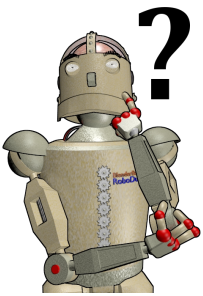
? ## Chapter 11 Reflection and Wrap-up:

3D Text in the World

3D text can add depth to any image or movie with professional-looking results. Even 3D text rendered with a transparent background can make a great title overlay in a movie.

1. Select a popular movie company's logo that uses 3D text and can be seen in blockbuster movies. How do they use text effects to create a stunning logo? Explain your thoughts.

2. Some standard text fonts do not work for 3D models. They will not extrude properly or can exhibit strange bevel effects. This isn't just a Blender issue, but an issue with all 3D modeling programs. Why do you think this is a problem? Research the internet to see if your thoughts are correct. Explain.

3. Text on a curve typically only work one way (curving along the base), but how could you curve it upright, as shown here? There are several ways to do it. How would you make it work? Research the internet if needed. (Hint: convert it to a mesh). Explain your answer.
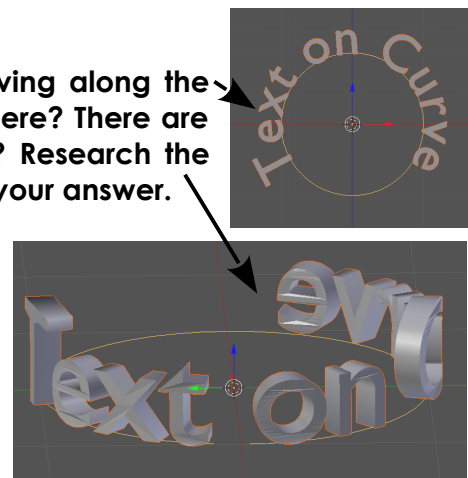
When you press "**Shift-A**" for "**Add**", you will notice other object types beside meshes, cameras and lights that can be created. Two types of objects that can be created are **Surfaces** (NURBS) and **Meta Objects**. A lot can be said about surfaces, but for this tutorial, I want you just to become aware that they are there and describe some basics about them. Meta objects have been expanded to a variety of shapes and can be used to give you a "liquid metal" effect where the objects "pull" together as they become close to each other.

Using NURBS to Create Lofted Shapes (surfaces)

If you look at the **Surface** menu, you will see a variety of shapes that can be created. These shapes can be use as they are or converted to meshes so you can work with traditional vertices. *To convert a surface into a mesh, select the object and press the "Alt" and "C" keys and choose the appropriate option.* You can do a lot with NURBS and there are several tutorials online describing them, but for now, we will just work with a **NURBS Circle** to create an interesting looking tunnel.
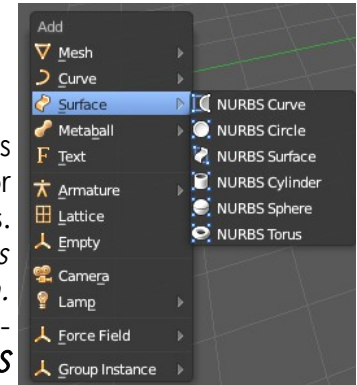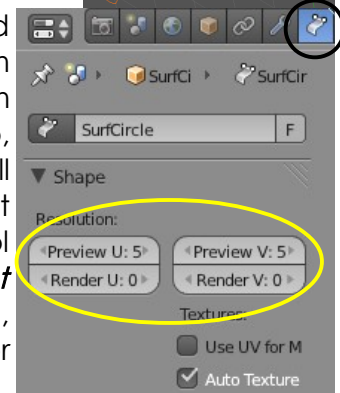
Creating a Lofted Tunnel

This process will take several profiles of a NURBS Circle and connect them together. First thing you need to do is create a **NURBS Circle**. To do this, press "**Shift-A**", select "**Surface**" and "**NURBS Circle**". In *Edit Mode*, select the points and shape the circle a bit. After shaping, exit edit mode.
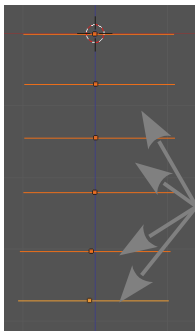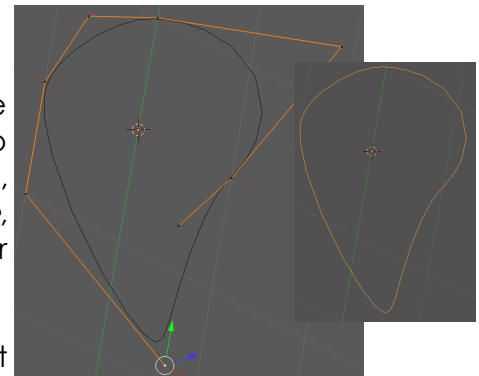
Change your view so you are looking at the edge of the circle (*try front view if circle was made in a top view*). You may also want to switch to a wireframe view. Use the "**Shift-D**" keys to duplicate the circle several times. Then rotate your view so you can select each circle and edit the shapes in **edit mode** (Tab key).
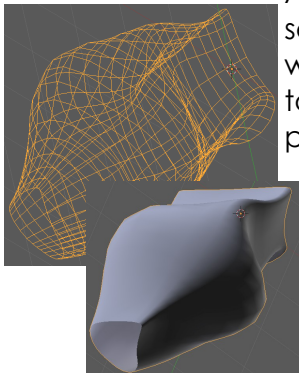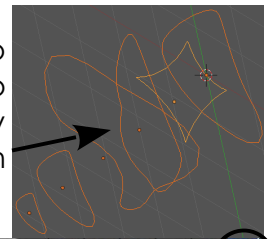
After shaping the circles, exit edit mode and select them all by RMB clicking on them while holding the "**Shift**" key. To join them together, press "**Ctrl- J**". For the final step, press "**Tab**" for edit mode, "**A**" to select all verticies, then "**F**" for face. Your result should be a lofted object. You can control the detail of the shape in the "**Object Data**" panel. If you need it to be a mesh, press "**Alt-C**". This is a great technique for making boat hulls and other related items.

Liquid and Droplet Effects Using Meta Shapes

Up until a few releases ago, Blender only had the capability to make one Meta shape- a ball. Interest grew, programmers added other shapes and cleaned up the code. You can now make several different meta shapes in Blender. They all work with the same principle. As the shapes get close to one another, they begin to "pull" and flow together. As meta shapes combine, their mass grows which is ideal for certain animations. Meta shapes can be animated like other objects and can be textured. Ray-tracing settings like reflection and transparency can also create some stunning effects. Meta shapes are created like other objects, *except that the first shape acts like a parent to the other shapes*. As that shape is moved, the others display a rotation. Materials are also linked for all meta shapes.
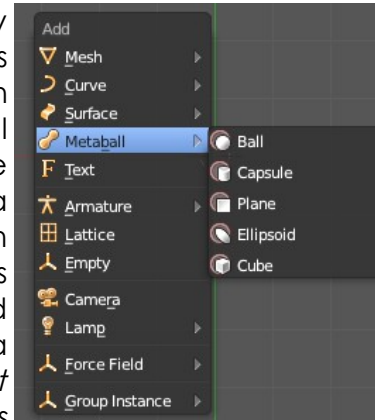
Meta shapes can seem a bit confusing at first because of their interactions. For example, individual meta objects are selected by RMB clicking on the _Selector Ring_ around the object. When clicking on the actual meta shape "mesh" itself, all shaped are selected. Remember that meta shapes are linked and controlled by the first meta added. By selecting the object, materials are linked to all shapes. Remember to select the ring to transform just that object. Meta shapes can be scaled, rotated, moved, and combined for different effects. You can also control the quality and effect of the meta shapes in the properties window. Experiment with these to get a desired effect.

Selector Ring   Meta Object   Meta Settings
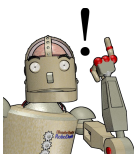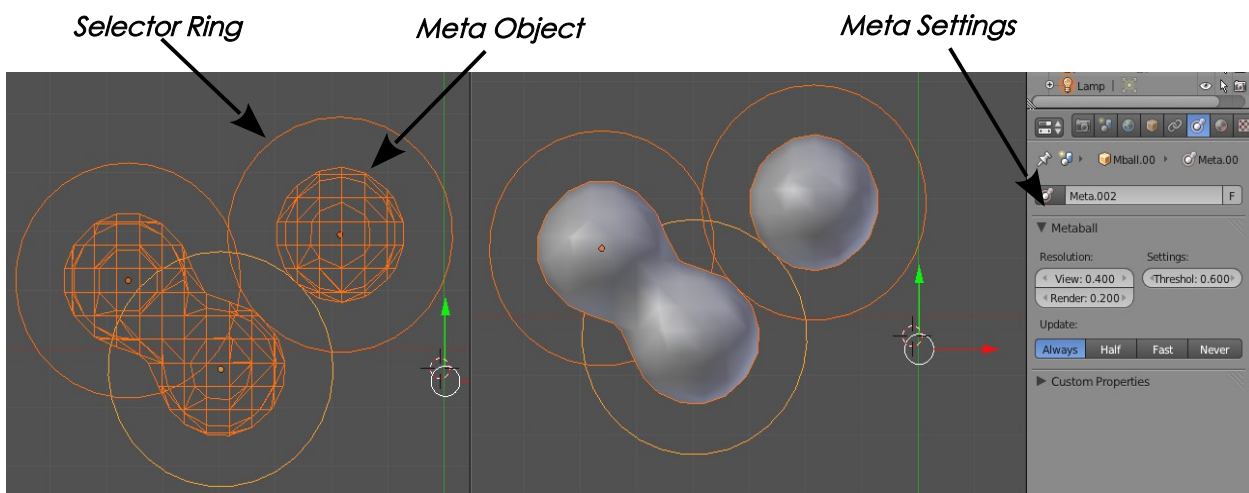

RoboDude Asks:
Why are all my Meta shapes joined together?
If you get into Edit mode while making your meta shapes, they will all join together. Remember to be in Object mode while making Meta shapes.

Create a new Blender Scene, erase the initial cube and name it "Lava Lamp". For this activity, we will be extruding circles, lofting NURB circles and using meta balls to create an interesting lava lamp.

Begin by making a *Mesh Circle* in the top view and select the *Fill* option in the Tool Shelf to fill the circle. In the *Front View*, enter *Edit Mode* and *Extrude* (E key) the circle to form the base of the lava lamp to a shape something like seen to the right. You will want to Smooth (Tool Shelf) and Auto-Smooth (Object Data buttons) the base. Set the Auto-Smoothing angle to your desire.
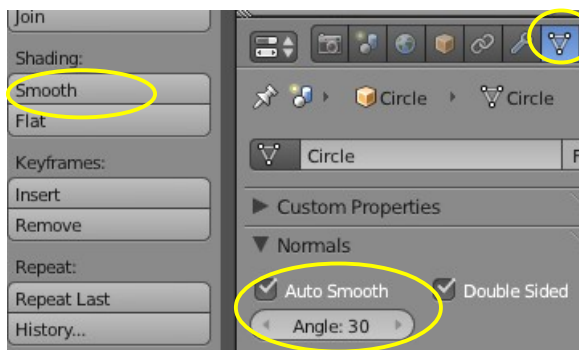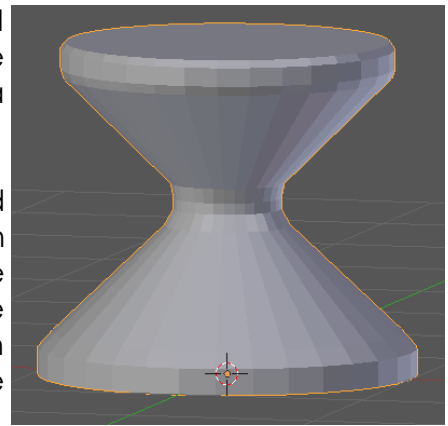
We could make the glass bottle by extruding a circle exactly as we did the base, but for practice, let's loft the shape by using *NURBS Surface Circles.* Go to the *Add- Surface* menu and add a *NURBS Circle*.
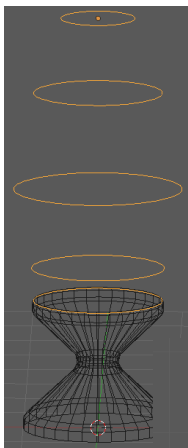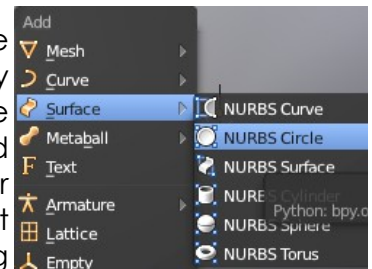
After adding the NURBS Circle, switch to a front view and duplicate it a few times. Size them to match the shape you want for the lamp. While holding the "*Shift*" key, select all the circles and joAin them together with "*Ctrl-J*" or the "*Join*" command in the tool shelf.

It's now time to give the circles a surface. Enter *Edit Mode* and select all vertices with the "A" key. Press the "F" key to face the circles. It may not look exactly as you wish so you may need to deselect all vertices (*"A" key*) and box select (*"B" key*) a single ring of vertices in the front view to move or scale them.

When finished, the shape should look something like the image to the left.

The final step is to convert the NURBS Surface to a mesh. This is done by pressing "*Alt-C*" and selecting "*Mesh from Curve/Meta/Surf/Text*". Set Smooth and Auto Smooth.

P E R F O R M A N C E   T A S K S
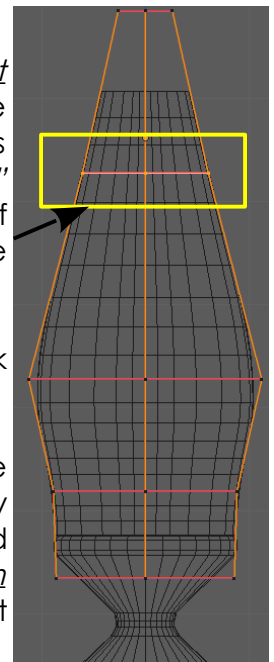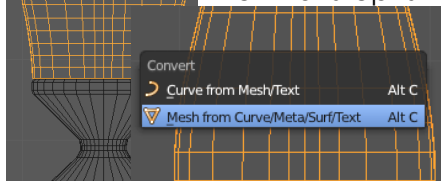
The Lava Lamp

The next step it to create a top for the lamp. Do this the same way we made the base, using a *Circle* mesh. After shaping the mesh and applying *Smooth* and *Auto Smooth*, it may look something like the image to the right. To correct this, we need to change the *Normal* settings of the faces. Enter *Edit Mode* and select all vertices. In the *Tool Shelf,* find the options for <u>*Normals*</u>. Try pressing both "<u>*Recalculate*</u>" and "<u>*Flip Directions*</u>". This should correct the problem.
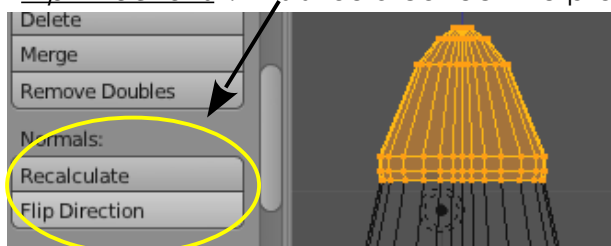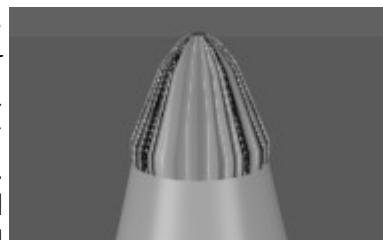
It's now time to get a nice render of your lamp. Apply a nice material to all 3 objects, using Ray-transparency on the glass bottle. Experiment with your *Fresnel* and *IOR (refraction)* settings. You may also want to take the *Depth* setting up a bit.
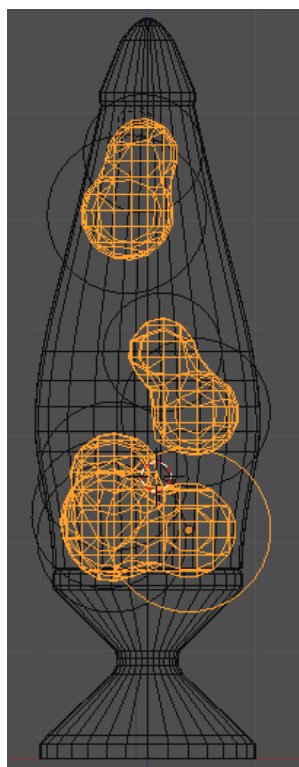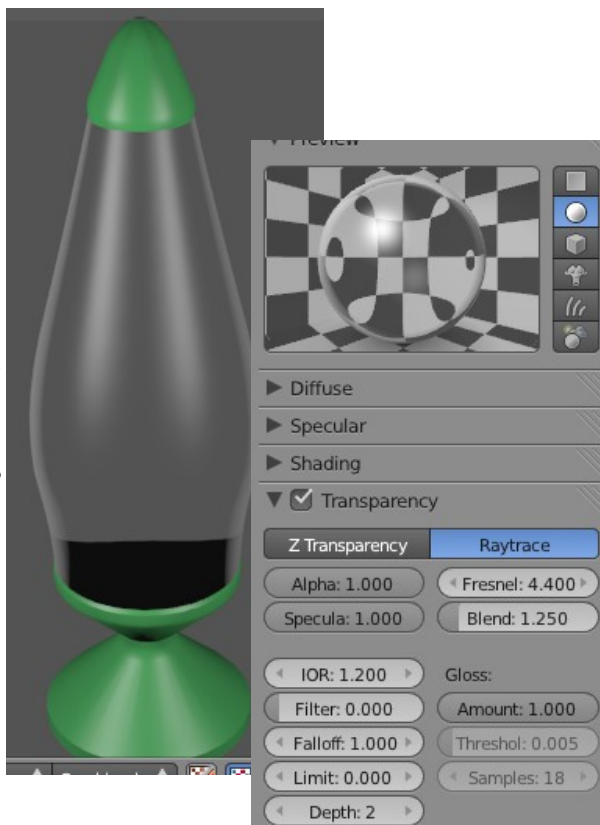
With the lamp finished, it's time to add the lava. Start by adding a <u>*Meta Ball*</u> shape. Remember that this first shape controls the material and action of the other meta shapes. Add as many meta shapes as you wish. Scale as needed. Use all 3 principle views to get your locations correct and all shapes are in the bottle. Add a material and render an image.
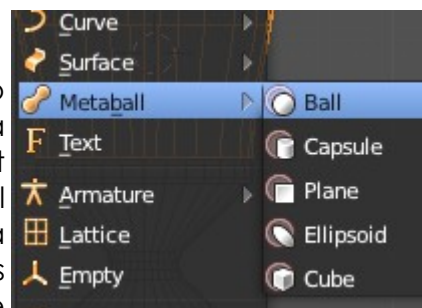
Your lava lamp should look something like the image to the left. Even though you applied a material (*I used green*), the meta shapes will probably appear black. This is due to the lighting effects and the ray-tracing on the bottle.

To fix this, go back to your *Material* settings on the meta shapes and find the *Emit* slider under *Shading*. This will now give you a green color, but the shapes will look flat.

Our next step is to add a *Point Lamp* at the bottom of the bottle. In the lamp settings, turn off all shadow effects for this lamp. At your next render, you should see some effects on your lava.
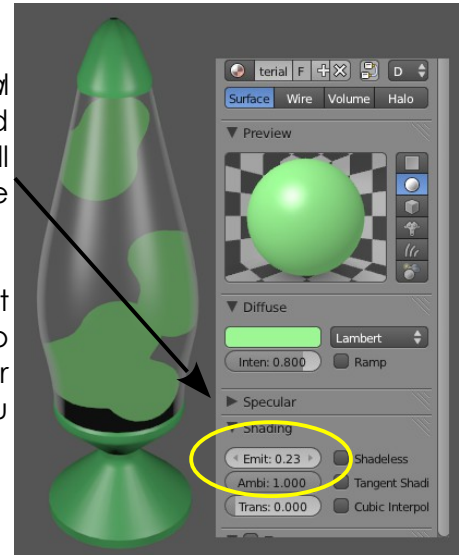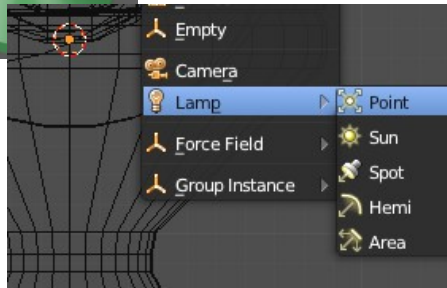
Looking better, but we can make use of the Indirect Lighting features discussed back in chapter 7. Because we used the material *Emitter* feature on the lava, by making some changes in the World buttons, it will glow.
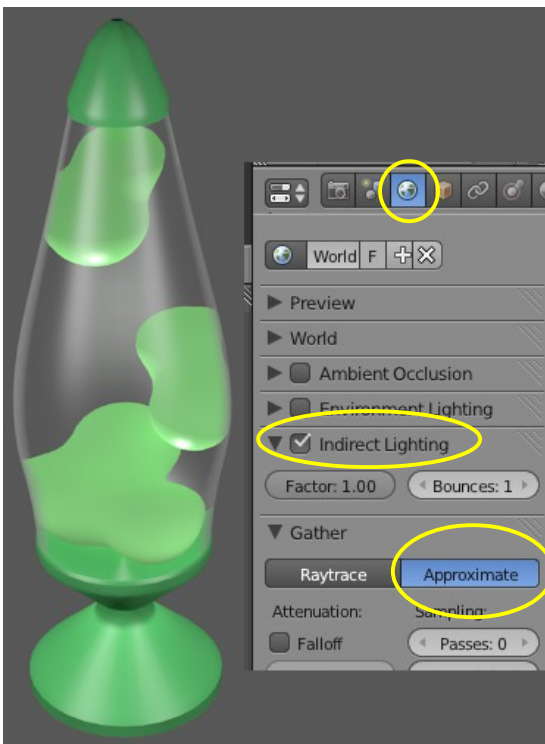
Go to the World button and select "*Approximate*" in the *Gather* panel. Check the box in the *Indirect Lighting* panel to use the feature. Render an image and check your results. Fine tune your adjustments if needed.

If time allows, animate your lamp and make a movie.
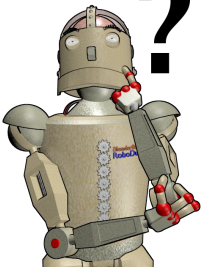
*** Call the instructor when finished ***

PERFORMANCE TASKS

The Spill

Using your design skills and imagination, create a realistic scene of a fluid spill using meta shapes. A possible scene could be something like this. Add as much detail and realism to the scene as time allows.

When finished, Save a .png image file of your scene.

Chapter 12 Reflection and Wrap-up:

## Program Interfaces and User Reactions

NURBS is an acronym for non-uniform rational B-spline. They are useful for making point-controlled curves in 3D and we experienced how to generate objects in Blender using them.

1. From internet research, find an application of NURBS in Blender besides how we used them. What did you discover? Explain.

2. Meta Shapes can be used to represent many things in 3D models and animations. We used them to represent a spilled liquid and the lava lamp wax. Think outside of the box. Discuss two other ways that you think meta shapes can be used in a 3D scene. What could we use them to represent?

The modifier list continues to grow with each new release of Blender. We have already discussed the *Subdivision Surface (SubSurf) and Ocean* modifiers in previous chapters and will now look at some of the other modifiers. Others will be discussed in later chapters. Depending on the type of object selected, the modifiers fly-out may display different options. For basic meshes, here is what you see:
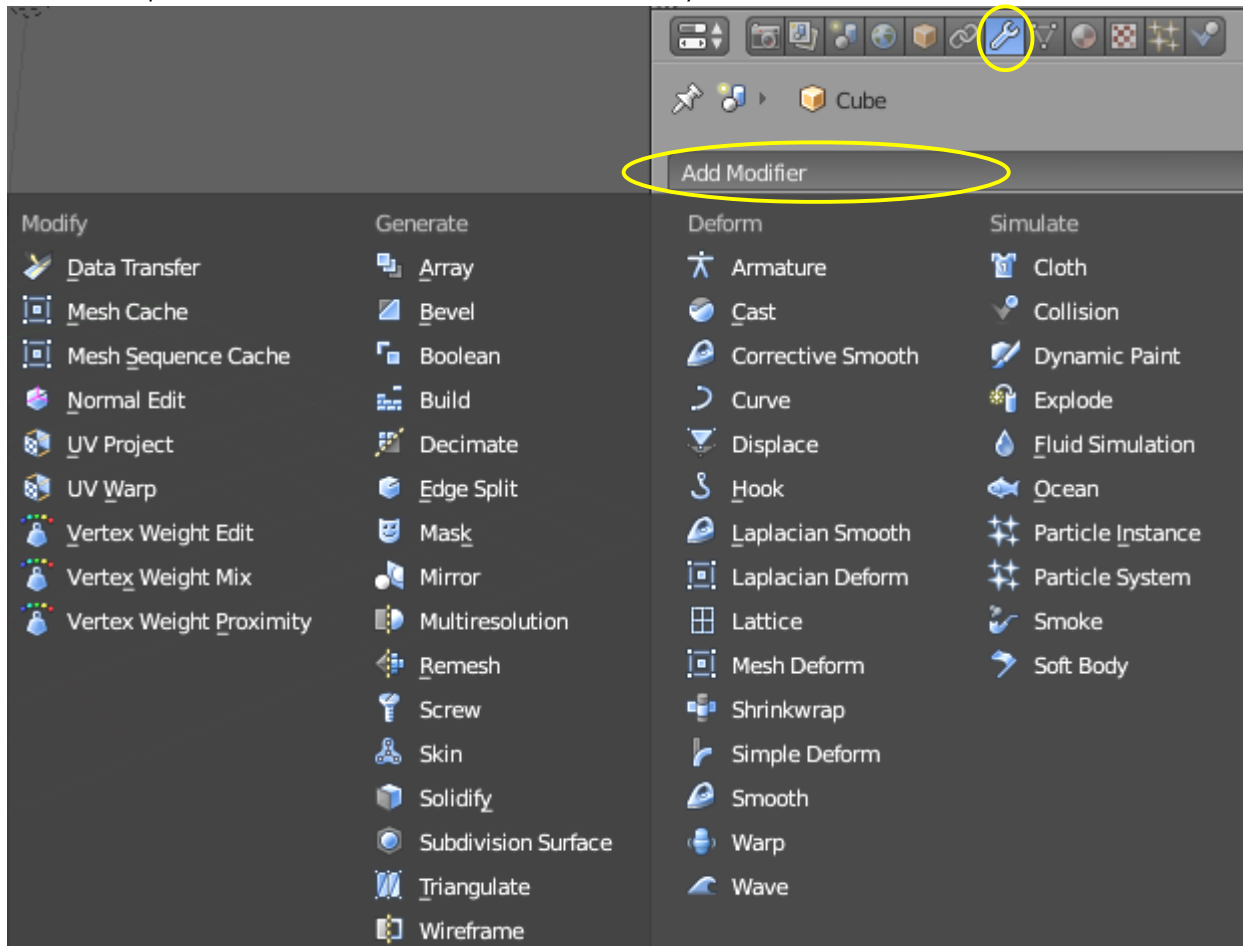

Generate Modifiers

Some of the Generate modifiers are self-explanatory while others need more discussion. Here are some of the basic options:

Array

The Array modifier works great for making patterned copies of an object. If you need rows and columns, add 2 Array modifiers and set the X,Y,Z Offsets as needed to obtain your pattern. By checking the "Object Offset button and selecting a control object (like an Empty), you can spin and scale the array.
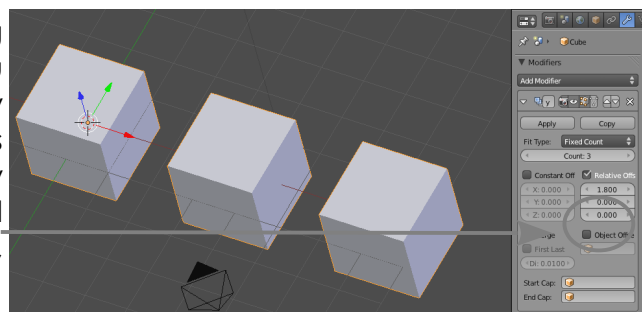
Chapter 13 - Modifiers
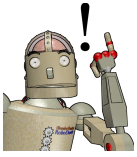
> **RoboDude Asks:** **What does the "Apply" button do in a Modifier panel?**
> *Until you hit apply, you can always change the settings of the feature. Once you hit the apply button, the modifier panel disappears and the feature becomes fixed and unchangeable. For example, applying a bevel modifier will then fix the bevel, changeable only in edit mode by moving vertices or faces. Same effect as applying the mirror modifier.*

Bevel
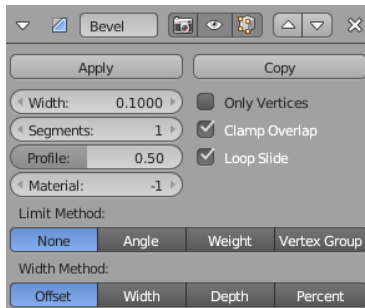
The Bevel modifier will apply a bevel, or chamfer, to the edges of simple meshes. There are a few options that can be set.
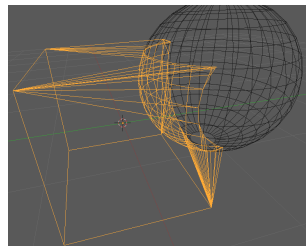
Boolean

The Boolean modifier is an important feature. It allows you to cut holes, join meshes that recalculate verticies and create new shapes from shared areas. To use the Boolean modifier, create 2 shapes- one that will be effected and one that will cause the effect. For my example, I've created a cube and a sphere. If you want to see the effect on the cube, select the cube and add a Boolean modifier. In the "*Object*" box, select the "*Sphere*". Under "*Operation*", select "*Intersection*", "*Union", or "Difference"*. When you get your desired results, hit "*Apply*". Sometimes, you don't get exactly the results you desire and need to erase some faces or move some vertices in edit mode. See results below:
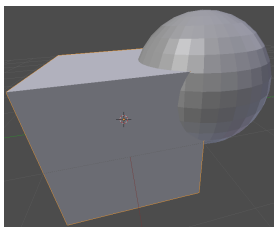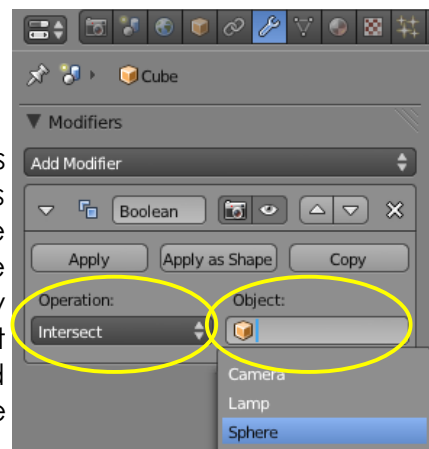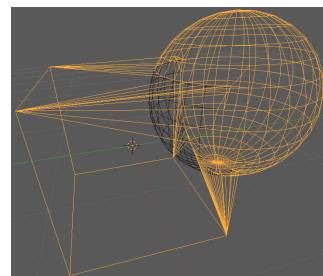
Basic Shapes- Cube selected
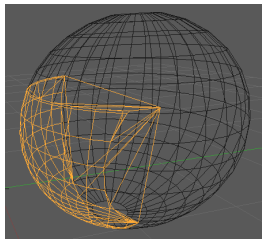
Boolean Intersection (shared area)

Boolean Difference (subtracted area)

Boolean Union (combined area)

Build

The Build modifier will take a mesh and build, or create, it over a specified time. Use the subdivide command to add more faces for a better effect. You can control the start and end frame times, randomize and seed pattern. A useful effect for having something appear and build in an animation.
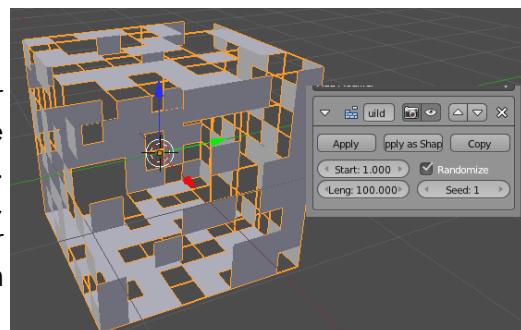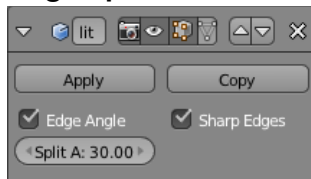
Decimate

Let's say you made an object and subdivided it too many times or need to simplify it for using in the game engine. Changing the "Ratio", then hitting the "Apply" button will simplify the mesh.
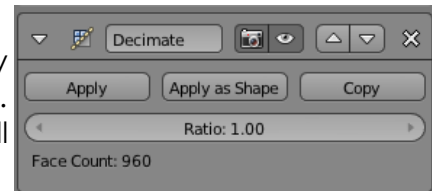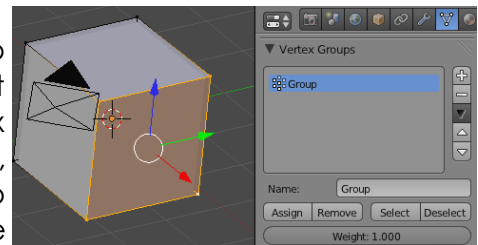
Edge Split

Edge split allows you to split a mesh into individual faces. Basically, you are taking the shared verticies at intersections and duplicating them so all faces have their own set of points. Edges are split depending on the angle setting. Hit "Apply" to see results, then enter "Edit Mode" to select those faces.

Mask

The Mask modifier allows you to select a vertex group previously created for the selected mesh and filter out everything else, or just that group. To create vertex groups, you need to go to the "*Object Data*" panel, create a new group and assign selected verticies to that group. Vertex groups are used for many features in Blender, some being demonstrated in later chapters. After the group has been created, you can add the Mask modifier, select the group and any other desired features like the "*Invert*" option.

Mirror

When modeling a symmetrical object (like a face, body or car), it is useful to only model half the object. To do this, move the object's center point to the objects mirror axis and keep all verticies to one side of the mirror axis. Add a Mirror modifier and select the X,Y, or Z (or multiple) axis planes and other options. You can also use another object to mirror around. After you have shaped the object, hit "Apply" to set the mesh.
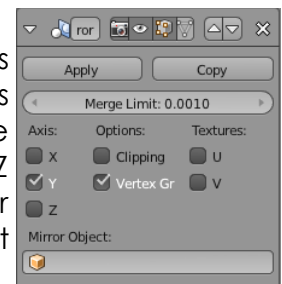
Multi-resolution

Multi-resolution allows you to add different levels of resolution quality to a mesh as rendered and displayed on the screen. Useful for speeding up working and rendering.

Screw

The Screw modifier allows you to create spiral objects differently than the "*Screw*" option found in the *Tool Shelf* in edit mode. The screw modifier works best with flat 2D objects like planes. By default, the feature uses the object's center point as it's spin reference, but other objects can be selected. You can select the spin axis, angle, step quality, and turns (iterations).
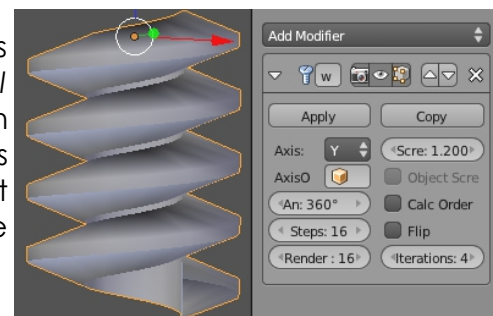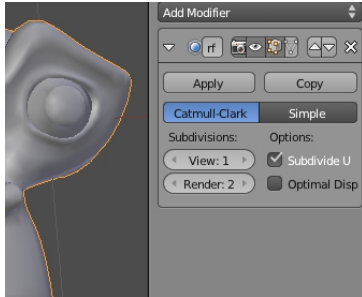
Chapter 13 - Modifiers

Solidify

If you are making an object like a glass or mug, if you only extrude the outer face of the object, it will not have any thickness. The Solidify modifier allows you to give the object some wall thickness.
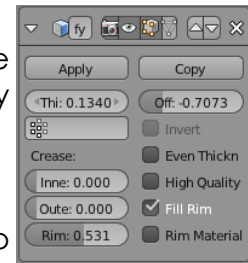
Subdivision Surface

The "SubSurf" modifier allows you to keep your mesh simple with as few vertices as possible, but render as a much more detailed mesh. Try adding a monkey head mesh, hit "Smooth" in the Tool Shelf, then add a Subdivision Surface modifier. If you enter Edit Mode, the mesh is still simple, but SubSurf has divided the faces for more detail. Be careful not to take the setting too high or your scene will slow down.

Deform Modifiers

While the *Generate* modifiers allowed certain modifications to the object, the *Deform* modifiers are used to change the object or use other objects for control.

Armature

An armature is a skeleton used to deform a mesh. It can be used for creating characters, suspension on cars and much more. Armatures are discussed in more detail in a later chapter.
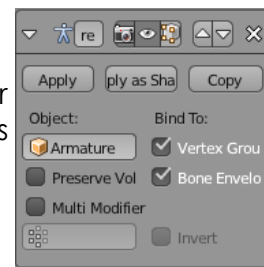
Cast
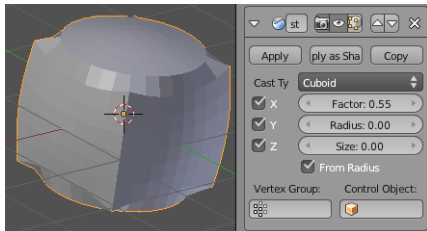
The Cast modifier can be used to round or square a mesh. The example to the left used a UV Sphere and a cast type of Cuboid. The sphere has started to take on the shape of a cube. Make sure you have plenty of vertices to get a desirable shape.

Curve

The Curve modifier allows you to use a curve to shape a mesh. Start by creating a mesh that is subdivided or extruded with enough vertices to "bend". Create a curve and apply the Curve modifier to the mesh (not the curve). Shaping the curve will bend the mesh.
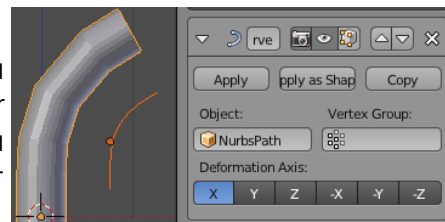
Displace

The Displace modifier works like the Displacement setting in the Textures panel(*discussed in the Materials and Textures chapter*). Create an object with many vertices, apply a texture and use it with the Displace modifier. The example to the right is a cube.
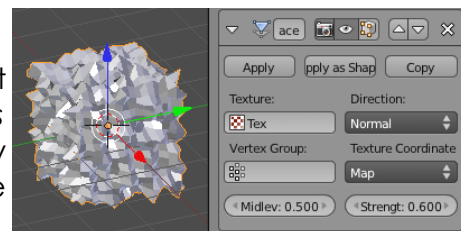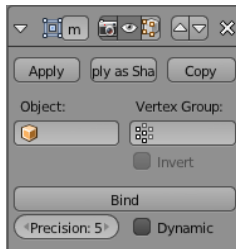
Hook

Hooks are used to animate an object using another object. Often, you will create vertex groups (*discussed in Chapter 13 and 16*) and tie them to an object, like an Empty. With the object selected and in *Edit Mode*, you can "Reset" and "Recenter" the mesh's points for better interaction.
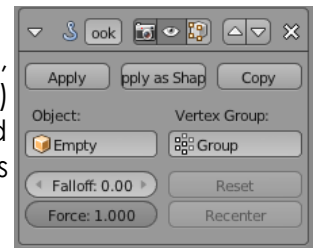
Mesh Deform

The Mesh Deform Modifier allows you to "Bind" one mesh to another and use it to control it's shape. Vertex groups can also be assigned for control. In order to use it, the controlled shape (the shape with the modifier on it) must be contained within the control object and the control object must be a closed mesh. Depending on the complexity of the meshes, the computer may lag when the "Bind" button is pressed.

Shrinkwrap

Shrinkwrap is a relatively new modifier that allows you to wrap a mesh around another mesh. For example, a subdivided plane can be molded around another object. You can select a target object to wrap around and a vertex group to control the shape.
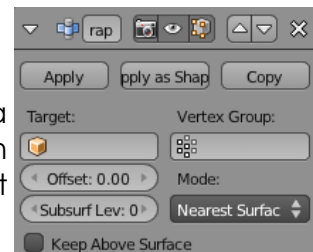
Simple Deform

Simple Deform is a handy modifier that can do a variety of simple modifications to a mesh. You can Stretch, Taper, Bend and Twist a mesh using the Mode and Deform settings. The complexity of the deform can relate the the number of subdivisions and vertex groups used.
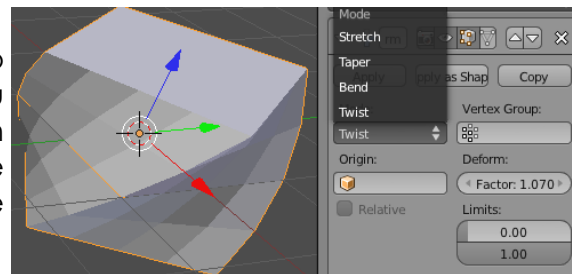
Smooth

The Smooth modifier will attempt to smooth out a mesh or vertex group that may be sharper than you wish.
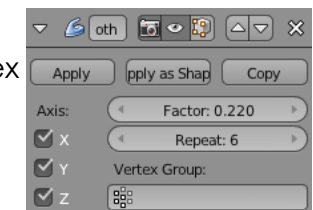
Wave
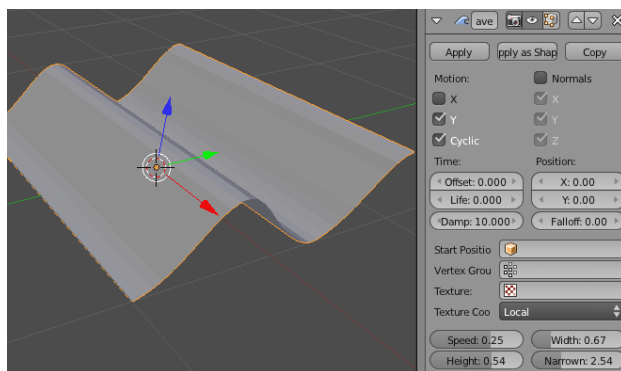
The Wave modifier is a useful modifier for animating a simple oscillation effect. You can control the axis of the wave, speed, height, width and narrowness. If you start with a simple plane, you will need to subdivide it to see the oscillation. This is an animated effect so press "Alt-A" to see the results of your settings. A simple way to make a ripple.

Chapter 13 - Modifiers

Simulate Modifiers

The *Simulate* modifiers work with Blender's physics engine in order to create animations dealing with particles (fire, explosions, strands), cloth, fluids, soft-bodies, smoke, forces and collisions. When applying most of these modifiers, you will need to go to the *Physics and Particles* panel to adjust the settings. All of these factors are discussed in later chapters, but here is what you can find in this modifier stack:

Cloth and Collision

The Cloth modifier can make a mesh act like fabric. The more vertices your mesh contains will make it appear more realistic, but at a cost of render time. The Collision modifier allows other objects to react with the cloth (also works with particles). The example shown uses a subdivided plane as the fabric and the sphere as the collision obstacle.
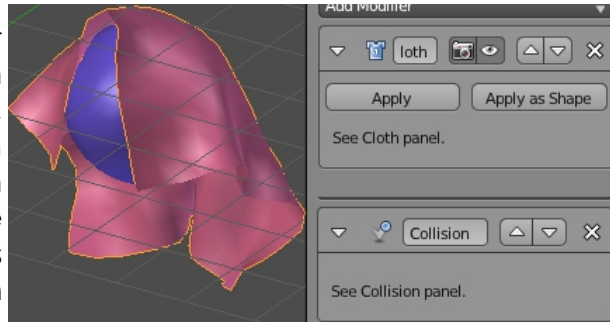
Particle and Explode

Particle systems are used to simulate many animation effects and discussed in their own chapter. Particles can simulate explosions, sparks, fire, smoke, grass, hair, and fireworks. After adding a particle modifier, you can then add the explode modifier to "explode" the mesh along with the effect.
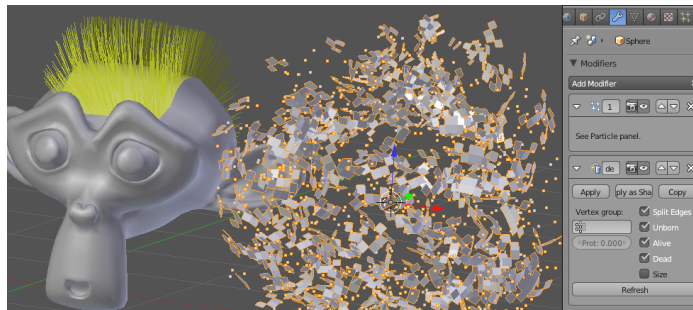
Fluid Simulation

The fluid simulations have seen improvements over previous versions. You can create inflow or fluid masses that splash and react.
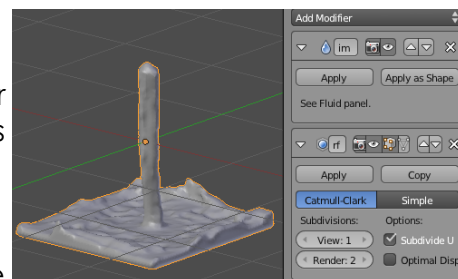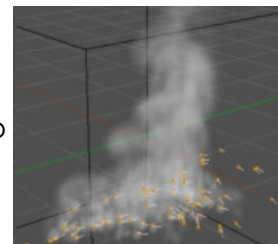
Soft Body

The Soft Body modifier existed before Blender had the Cloth modifier and was used to simulate cloth effects. Soft bodies can be used for fabric effects and "Jello" giggle effects. You can control the elasticity between vertices.

Smoke

The Smoke modifier was new for Blender 2.5. It can be used to create realistic smoke effects in your scene.

SoftBody

The Softbody modifier is controlled in the Physics panel and allows objects to flex and loose some rigidity, like Jello gelatin or fabrics. The cloth simulator was born out of softbodies several years ago to simplify the fabric process. The example shown to the right is a sphere being deformed by the wind.
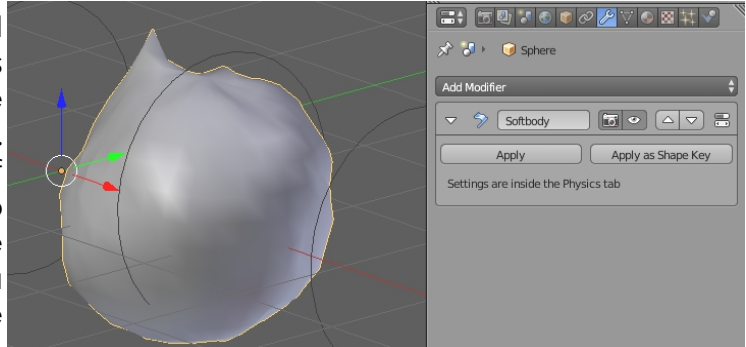
Ocean
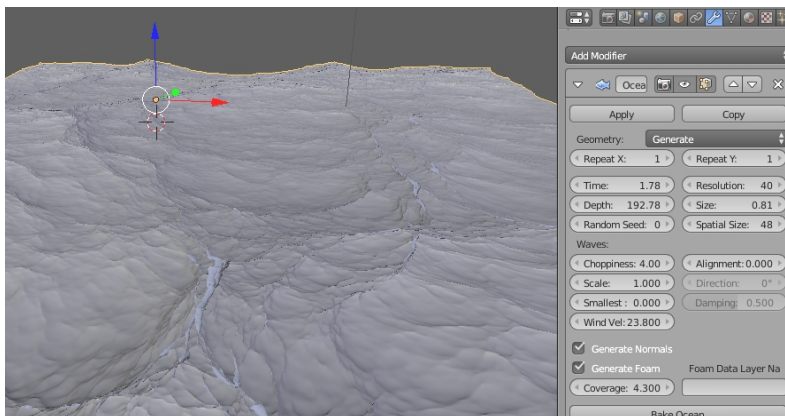
The ocean simulator can be used to create a very realistic-looking ocean. We used the ocean simulator for our lighthouse scene earlier in the book.

There are many more modifiers than we have discussed here and more will probably be added shortly after this book is published. Remember to look at www.blender.org and YouTube for more information about modifiers.

Mesh Errors and Modifier Problems

RoboDude Asks: I tried to use a Boolean modifier and it doesn't work- why?
For a Boolean modifier (and many other modifiers) to work, you need to have a clean mesh without double vertices or flipped faces. For Boolean operations, the mesh must also be closed and solid with no missing faces to work correctly.
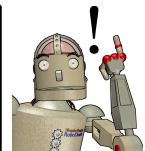
There are several *Tool Shelf* commands you may want to use if you encounter mesh problems, especially with Boolean operations. With the mesh selected, enter Edit mode, select all vertices, then:

- In the *Tools* tab on the Tool Shelf, select "Remove Doubles".
- In the *Shading/UVs* tab, select "Recalculate" under Normals to force the mesh to determine the correct direction of the faces.
- Finally, check to make sure there are no holes or overlapping faces in your mesh.
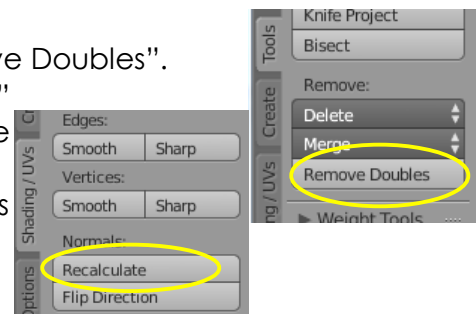
This will solve most modifier problems.

Common Modifiers Exercise

Create a new file and call it *Modifiers*. Create a scene using any objects and materials you wish. Place at least one of each of the following modifiers in your scene.

- **Subdivision Surface**
- **Build Effect**
- **Mesh Mirroring**
- **Wave Effect**
- **Boolean Operation**

Feel free to experiment with any of the other *Generate* and *Deform* modifiers.

Render a 200 frame movie of your scene when finished.
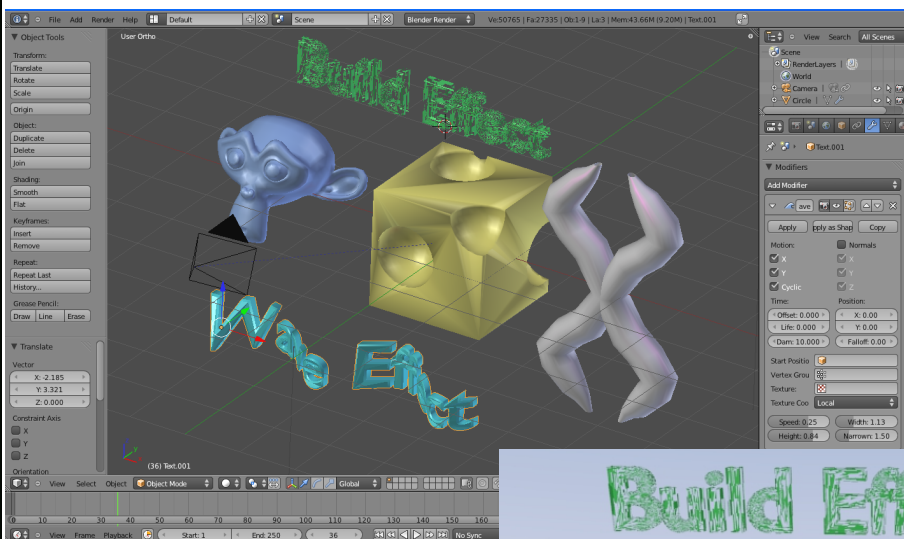
Other useful commands:

"Alt-C" to convert a curve or text to a mesh.

Tool Shelf command: move the Origin to a better location when using the mirror modifier.

** Call the instructor when finished*

Scenario:

An entomologist discovers you are a skilled 3D computer artist and commissions you to create a 3D model of an insect they are studying. Your goal is to create a 3D model of the insect with as much detail as possible.

Goal:

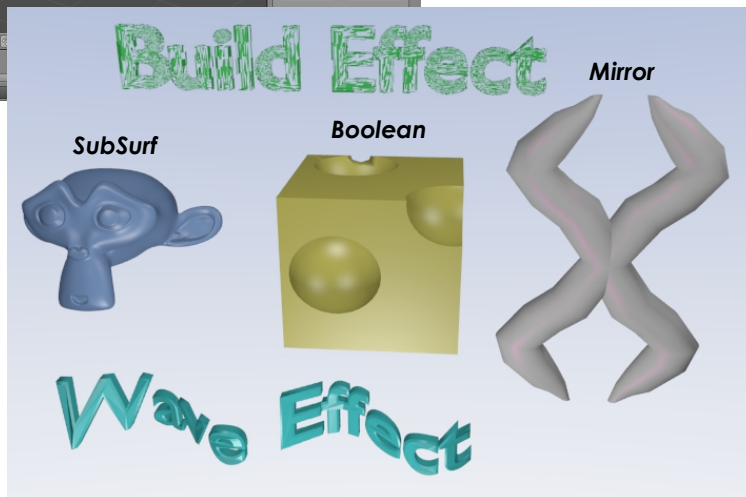Find images of an insect on the internet that you would like to model. Use Blender modifiers to assist you with the modeling process (i.e. Mirror, Boolean, Smooth, SubSurf, etc.). After you finish modeling the mesh, add appropriate materials and textures. You can find many examples of insects made in Blender on the internet for inspiration and guidance.
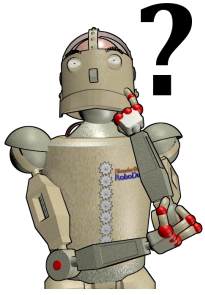
When finished, add appropriate lighting, world settings and other scene elements. Render and save an image.

** Call the instructor when finished**

? ## Chapter 13 Reflection and Wrap-up:

Blender Modifiers

Modifiers have been designed to make your modeling experience go much smoother, producing interesting results that would otherwise be very difficult to create. Take a few moments to reflect on these questions.

1. **From the modifiers that you experimented with, which did you find to be the most interesting and useful? Why?**

2. **The Build modifier can be used for some interesting effects. From your own thoughts, describe one possible use for the Build modifier.**

3. **The mirror modifier is useful for more than just mirroring an insect. Name at least 5 situations where the mirror modifier would be useful.**

4. **Boolean operations form the basis for not only many 3D modeling tools, but computer logic in general. Do some internet research on Boolean mathematics. George Boole was a man ahead of his time. What is Boolean logic and why is it so important for computers? Explain.**

This is probably the nicest and most flexible of the Blender effects. When you turn an object into particles, it can be used to simulate *snow, fire, smoke, clouds, sparks, hair, grass and much, much more*. When an object is turned into particles, it can releases particles per the settings you used on it and be represented by the mesh, particles, or even as other objects. With particles, you can set the size (using halo), texture, color and transparency through the material buttons. You can set the particles to come off the object in a **sequence or randomly** by using **random** setting in the particle panel. Particles can be set to be pulled using X,Y, and Z forces or gravity. You can control the number of particles, how long the particles live, when to start and end, if they have a starting speed and much more than we will describe in this chapter. Like all of the other features we've discussed, experimentation beyond this chapter is the best way to learn.

Particle Settings and Material Influence

At first glance, the particle setting in Blender can seem overwhelming! Because particles are so versatile, there are many things that can be changed for them. We will first look at the basic setting, then apply these settings to a few examples. With a mesh object selected and going to the particle settings, the first thing you need to do is press the "New" button to add a particle system. After pressing "New", you see several panels with options. The example below displays all panels collapsed for easier viewing:
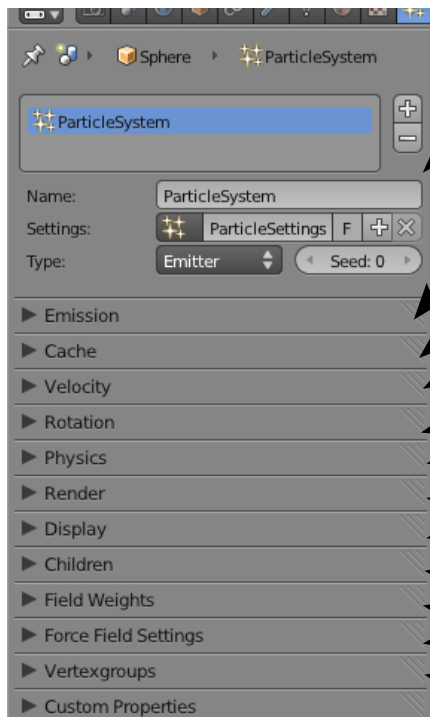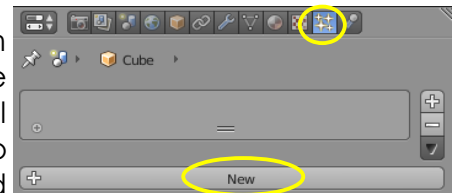
Basic Settings- This is where you name your system for easier reference, add additional systems and choose the particle type (*emitter or hair*) Hair is useful for any type of strand, like grass.

Emission- Number of particles, when they emit and how long they live when emitted.

Cache- In order to save computer processing time, you can "Bake" your particles so they are remembered.

Velocity- Sets an outward, normal (exploding) or directional force to start the particles.

Rotation- Gives your particles a spin.

Physics- Choose your physics calculation type, mass, size and drag.

Render/Display- How the particles look on screen and rendered.

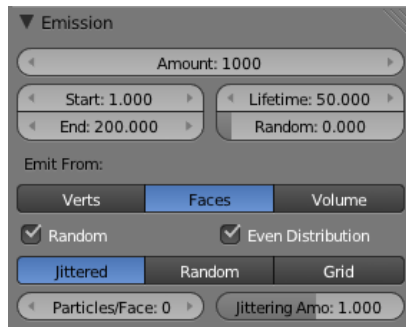**Children-** Saves render time by copying particles.

Weights and Force Fields- Controls factors like gravity, wind, turbulence, and drag

**Vertex Groups-** Setting groups to control distribution.

Particle Panel Basics

Some of the panel basic settings are explained below:

When adding a particle effect to a mesh, think of the mesh now acting like a collection of small parts, being created at various points in time, living for a while, then dying. In the **Emission** panel, you set the total amount of particles, when the particles start in time, when they end, how long each particle will live after birth and if you want some randomness to their lives. This is where you can also select *Random* for how they are emitted from the mesh, otherwise, they may appear to come off in a sequence.

The **Cache** panel is useful for saving you particle calculations so working and rendering can run faster. Every time you make a change to your particle settings, the computer needs to recalculate those changes over time. Saving this data in a folder or file will help a lot. This is called *Baking*. When you press "Alt-A" to see an animation on screen, Blender will temporarily *Cache* the data in memory while you work, but won't save it for a future session.
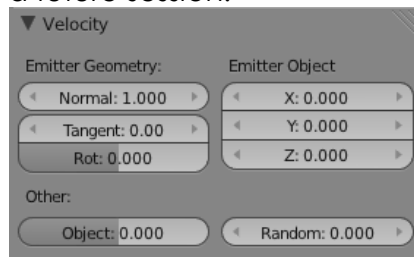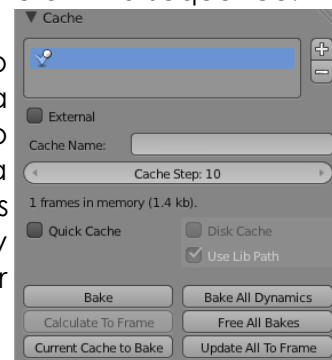
The most important settings in the **Velocity** panel are "*Normal*" and the "*X,Y,Z*" settings. Normal controls the outward force of the particles while X,Y,Z control the directional push. You also have a few other setting to adjust. The *Random* setting is also important to make the effect look more real.
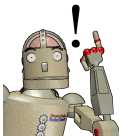
RoboDude Asks: *There are a lot of settings- how do I keep them straight?*
It is best to only make one or two changes at a time and test them out by pressing "Alt-A" to see the effects in the viewport. You can always "Ctrl-Z" to undo- and practice helps.

Check the box and the **Rotation** panel gives you options related to how the particles spin when released. If you are looking at random spinning and dynamics, it's good to set these high. You can also change what effects the spin (by default it is velocity).
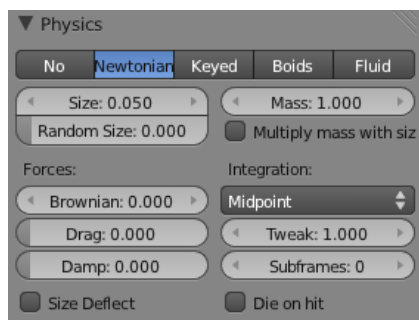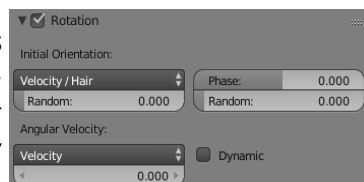
The **Physics** panel is where you can make some basic adjustments in the physics model used (default is Newtonian), size and randomness of particles, mass (when dealing with gravity and reactions) and dampening.

The **Render** panel provides setting for what the particles look like rendered (F12) or animated. If the *Emitter* button is not checked, you will see the particles and not the mesh that they are emitted from. You can also chose to see *Unborn/Died* particles. Particles can also be represented different ways such has *Halo* (material settings), *Line*, *Group*, or an actual *Mesh* Object.

The **Display** panel basically controls how your particles look on the screen. You can have them display what is actually rendered, Points, Circles, Crosses and also the percentage of the particles (helps with work flow).
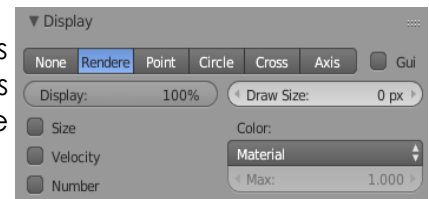
In the **Emission** panel, you set the amount of particles you want for your scene, but by setting the amount to a high setting (especially for hair or grass), you can greatly increase render time and slow down working on screen. The **Children** panel can help solve these problems. Basically, children are copies of a given particle so calculations only need to occur for each particle, then copies are made and grouped around that particle to make the scene more full. You can set the clumping, randomness, amount of children per particle and shape.

The **Field Weights** panel allows you to set useful features like *Gravity, Wind and Turbulence*. For example, if you are making a fire effect, You would want gravity at 0 and give "Z" an amount in the *Velocity* panel. For fireworks, only a slight gravity would be needed.
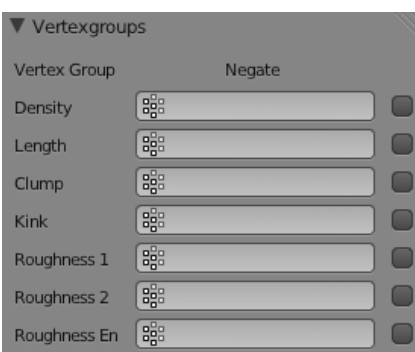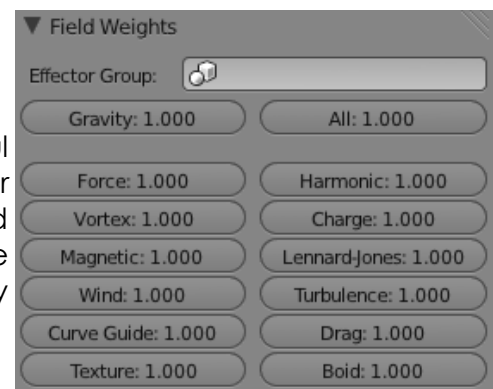
Vertex Groups can be used to control many aspects in particles. You can develop weights for density and other things. We will look at using groups later in this chapter when we use particles for hair and grass.

Chapter 14 – Particle Systems & Interactions

The **Force Field Settings** panel allows you to add additional features to your particle system. Features like Drag, Turbulence, Wind, Vortex, etc. can be added and animated.
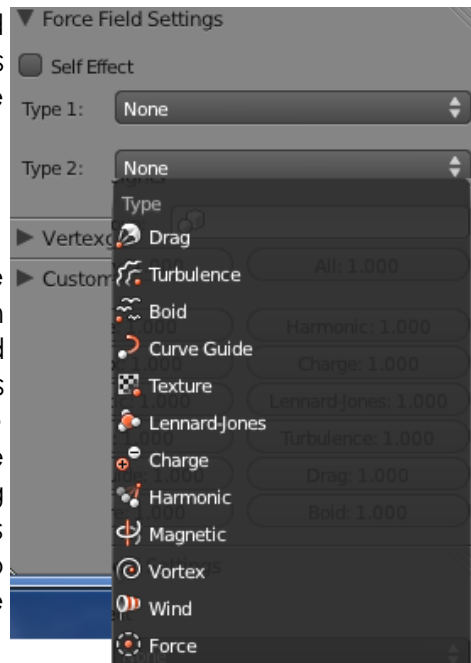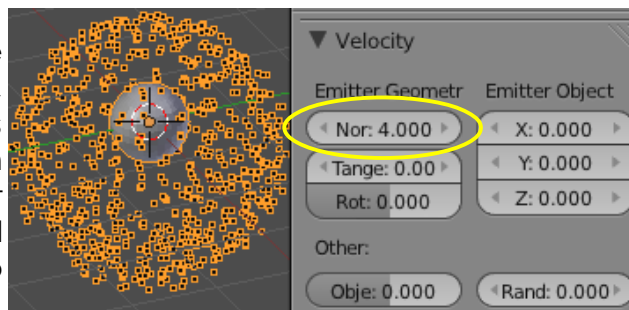
A Simple Particle Explosion (Fireworks):

Let's take some time to set up a simple particle explosion for practice using particle settings. Start with a new Blender scene, erase the initial *Cube*, then add a *UV Sphere*. *Scale* the sphere down to about ½ it's original size. In the *Properties* window, add a *Particle System* for the sphere. Press "Alt-A" to see the animated particles. You should see particles dropping off the sphere (spin your view to see the effects). Press "Esc" to exit the animation and use your arrow keys to move up in time to about frame 30. You should see something like the example below:
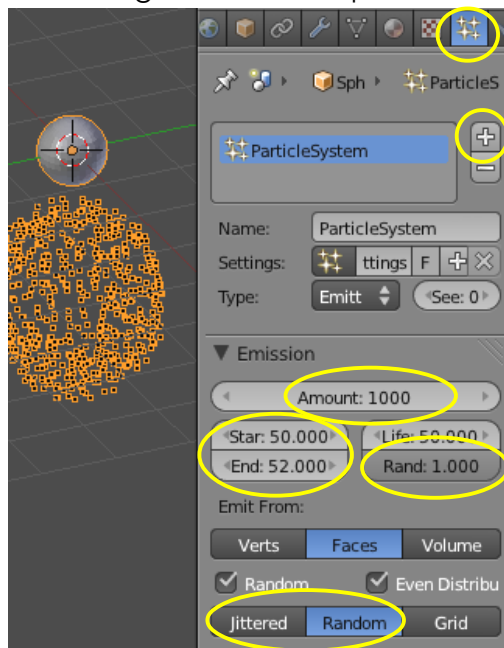
The particles are dropping because the gravity is set by default. We now need to make some changes to resemble a firework. First, start in the *Emission* panel and change the total *Amount* to about 300. No need for 1000 particles for a firework. Next, since a firework explodes over a short period of time, we need to change the *Start* and *End* frames to something much less. Try a *Start of 50* and an *End of 52*. This will cause all 300 particles to be release in 2 frames. Since firework particles die randomly, keep the Life at 50, but change the *Random* to full (1.000). Finally, change the Emit option from *Jittered* to *Random* to make the release of particles more random. Test it our with "Alt-A". The particles still drop so it's time to look at some other settings.

Next, in the *Velocity* panel, change the *Normal* setting to a much higher number, like 4.00. This will blast the particles outward. The gravity still pulls them downward a bit to much, so we'll fix that next. Go down to the *Field Weights* panel and set *Gravity* to about 0.40. Feel free to experiment with these setting for different effects.
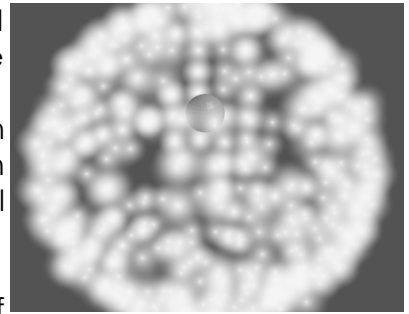
It's now time to put the camera in a good place and render an image. Advance to a frame where you see the particles well and hit "F12". You will see something like this:
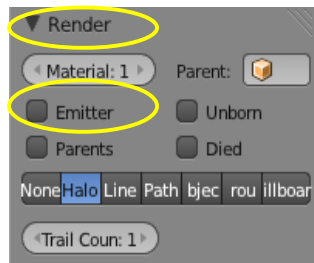
You may see the actual sphere in the center of the explosion. To turn this off, go to the *Render* panel under particles (*if you had the camera selected from before, select the sphere again*) and turn off "*Emitter*" so the actual mesh doesn't render. You could also experiment with *Trail Counts* for a second release. To improve the explosion, add a *Internal Renderer* material and adjust the *Halo* setting. (review *chapter 5*) Adjust the Diffuse Color, Halo Size and try Lines and Stars. You should end up with a nice effect.
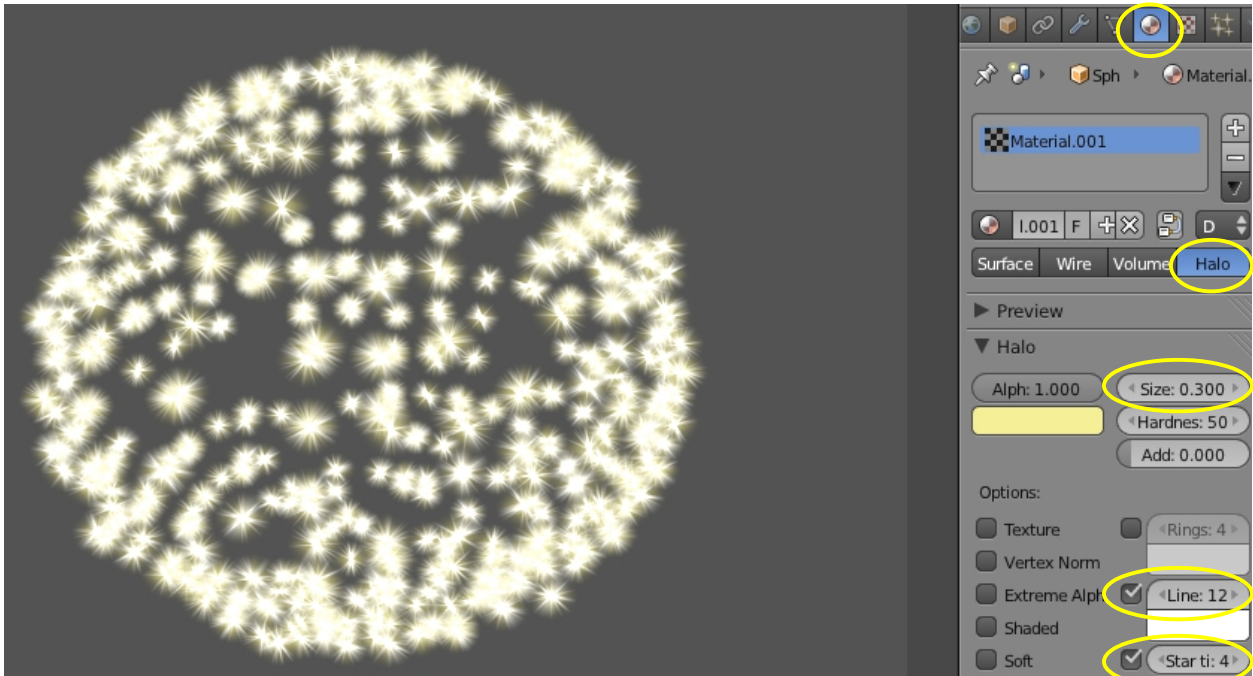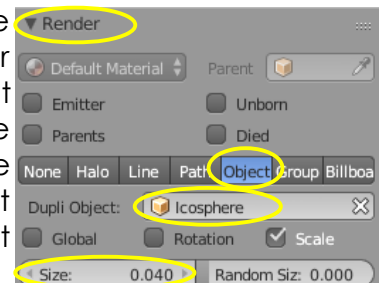
Material Influence:

Cycles and particles present some challenges that are not present in the internal render engine, but can give you some amazing results. Cycles needs true objects with volume to render and particles, by default, do not have volume. Realism can often be difficult to simulate with particles. We will examine using the internal render material strand settings later in the chapter. For now, let's take this simple explosion into Cycles to set up a node set that can work for this particle effect. The first step is to add an *Icosphere* that can be used to represent the particles. Icospheres have fewer faces to render and good for faster particles. Select the explosion again and in the Particles Render panel, select "Object" and click the box to find the Icosphere. You can set the size of the sphere particles.
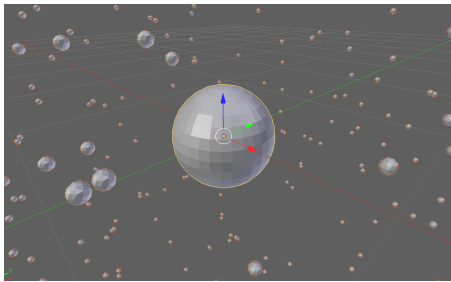
You should have a scene that looks something like the one shown to the left. Switch to *Cycles Render* at the top of the screen and switch to the *Node Editor* window. If you need a refresher on the Cycles render engine, review chapters 4 and 5.

Start by adding an *Emission* shader material node to the **Icosphere** (*not the particle sphere*). Set up the following nodes for the explosion material:

Particle Info Node- *From the Input node panel. Use Age and Lifetime to have the color fade out over the particle lifetime.*

ColorRamp Node- *From the Converter node panel. Set the left side ramp color to a good starting, bright color and a dimmer, fading-out color on the right. Just like colors fade in a real spark.*
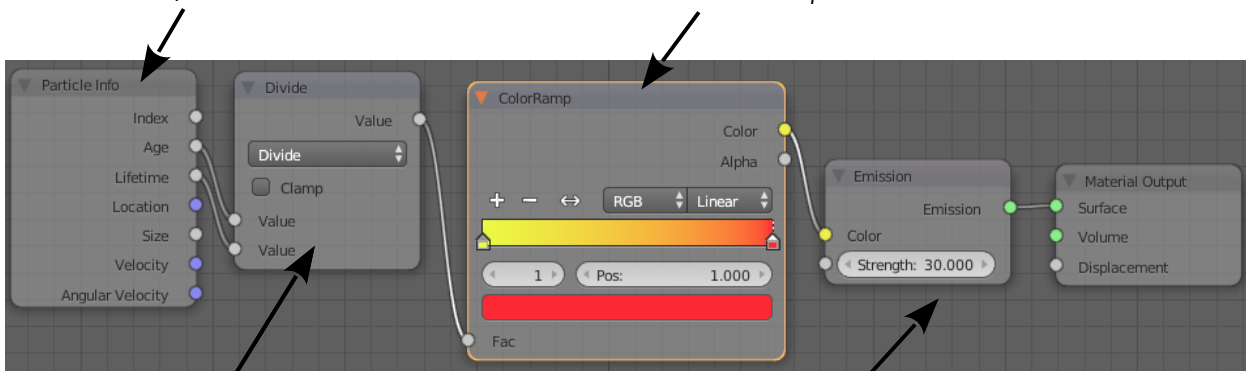
Math Node- *From the Converter node panel. Set to Divide to divide the lifetime to change the color over age.*

Emission & Output Nodes- *Increase the Emission Strength to about 30 for a brighter output. Connect all inputs and outputs as shown.*

Set up an appropriate world, adjust the size of the icosphere particles, and render your scene. You should have a nicely textured explosion. To add a realistic motion blur to the sparks, go to the *Render Properties* panel and enable the *Motion Blur* panel. Experiment with the *Shutter* setting to achieve an effect you want.
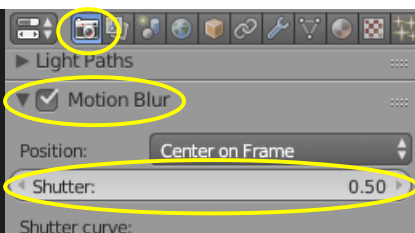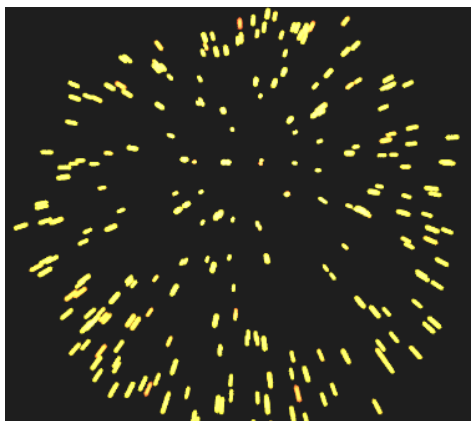
There are many other things you can do to your explosion from defocusing the camera to adding transparency shaders. The internet is full of useful particle samples.

Using the Explode Modifier

The Explode modifier adds a nice touch to making something explode. We will use the firework example from before to illustrate an explosion. In the _Render_ setting, turn on _Emitter_. First, turn off _Halo Lines_ and _Stars_ in the Material settings and set _Halo Size_ smaller, about 0.10. Add an _Explode_ modifier in the Modifiers panel. You may also want to check the "_Cut Edges_" box. Move to a frame where you can check the results. Also try "Alt-A". It's a nice start, but needs some work to look more believable.
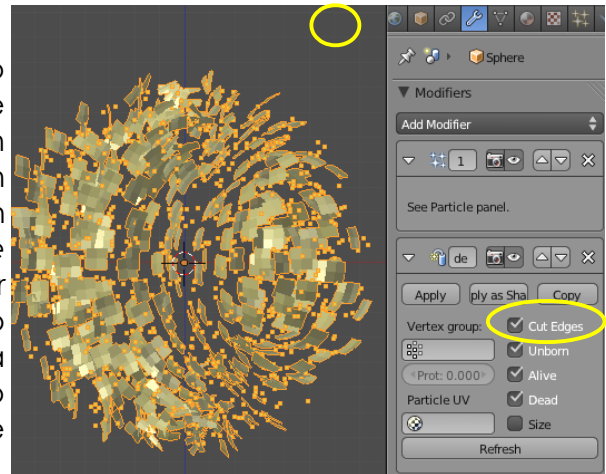
Now it's time to move back to the Particles settings panel. In the _Emission_ panel, you will want to set the _Life_ of the particles to 250 (length of the animation) and the Random

Life slider back to 0. To set the rotation to look more random and real, set the _Rotation_ and _Random_ setting to numbers between 0.500 and 1.000 in the _Velocity_ panel. In the _Rotation_ panel, check the _Dynamic_ box, add a _Random_ to the _Velocity_, _Randomize Rotation Phase_, and change the _Angular Velocity_ to _Random_ with a number like 6.00. The key to a good explosion is setting most random settings high. Feel free to experiment with other settings, but this should give you a nice result.
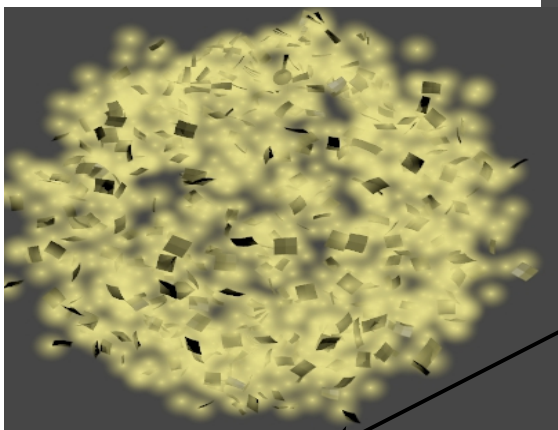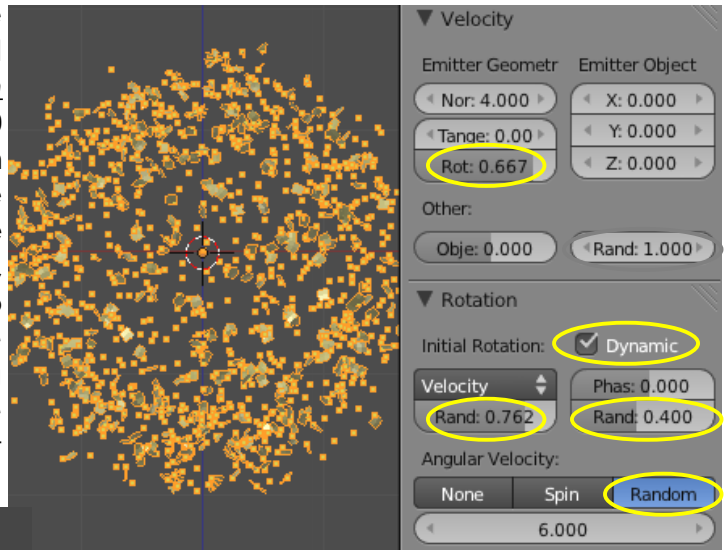
If you want an explosion without the halo particles displayed, trying setting the halo size in materials to 0. To add more depth you your animation, try adding a second mesh with a different color and particle settings. This will add levels and complexity to your scene. You can also add a secondary material in the Materials panel for just the particles on an object and assign that material in the Physics "Render" panel.
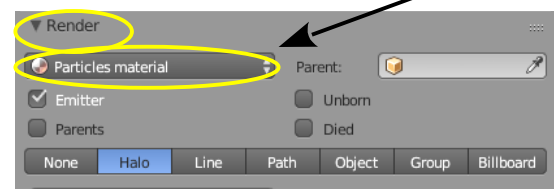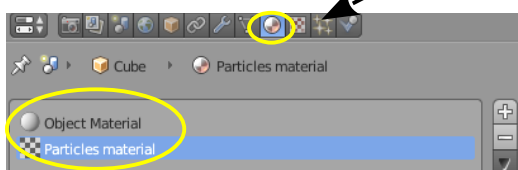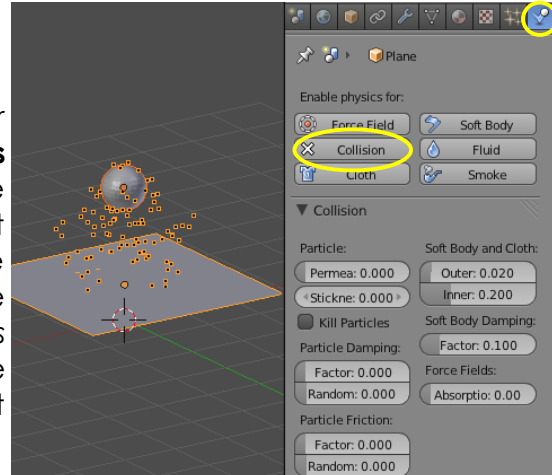
Particle Interaction With Objects and Forces

So far, we've looked at basic setting to get particles moving, but how can we add interactions to them? What if we want them to bounce off other objects or have wind blowing them?

**Interaction with Other Objects:**

You can make particles bounce off other objects using the _Collision_ setting in the **Physics** panel. For the example shown to the right, I've created a sphere with a simple particle effect applied and a plane below it. In order to get the particles to bounce when they collide with the plane, select the plane and go to the _Physics_ panel. Select _Collision_ and experiment with the settings under the _Particles_ column. You can set them to bounce, die or partly pass through.

Interaction With Forces:

Particles are able to react to forces like wind. They can now be applied directly to the particle system (_see Force Field Settings panel_) or added to another object. By applying the effect to the particle system, it can effect itself or effect other particle systems. By applying a wind force to another object, it can be animated to simulate wind changing directions.

For the example to the right, we will be using an _Empty_ as the wind force and a _Sphere_ with a particle effect with zero gravity. The Empty's display has been changed to "_Arrows_" representation for better understanding.
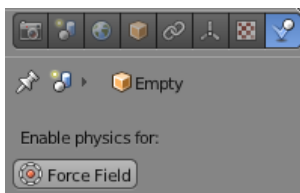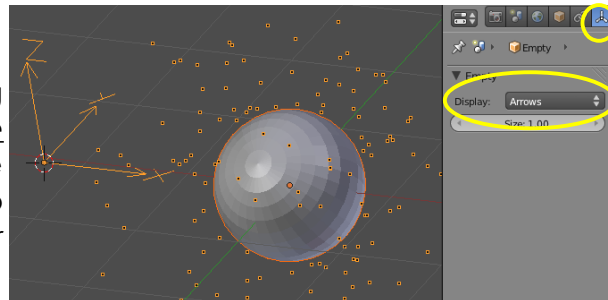
With the Empty selected, go to the _Physics_ panel and enable "_Force Field_". Select wind in the "Type" option and you will see several circles form on the Empty, indicating the force and direction. By default, the force will travel in the Z-direction. Rotate the Empty to point in the direction you wish the wind to blow. You can then adjust the strength, noise and other settings. For more change, you can also animated these setting by pressing "I" over a setting and changing it over time.
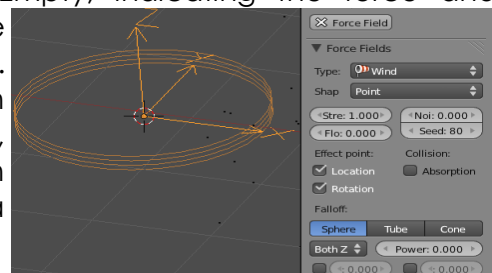
These setting are similar to many of the other forces that can be used on an object. These forces can also be used on many of the other physics features that will be discussed in a later chapter (cloth, fluids, softbodies).

Using Particles and Vertex Groups for Hair and Grass

At the beginning of the chapter we mentioned that particles can also be used to represent hair and grass. These features can be animated to react with forces and other objects. Hair can even be combed!
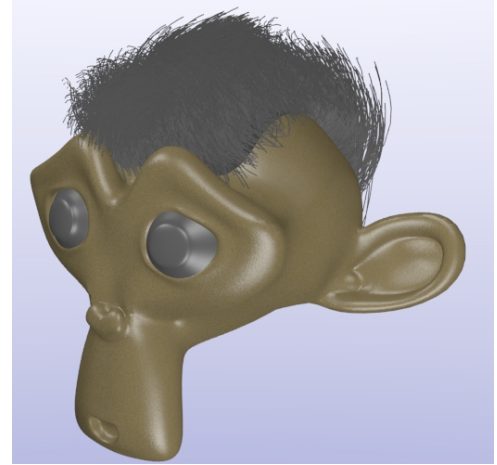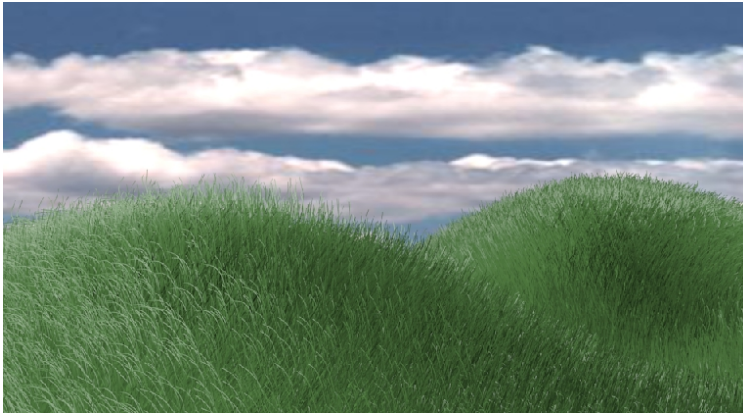
Basic Hair Settings:

For this basic setting discussion, I'll apply a particle system to a UV Sphere and switch from "Emitter" to "Hair" in the particle properties. You will probably get something like the scene below with long strand radiating out from the sphere. It's now time to adjust the *Hair* length under the *Emission* panel. I will set this example to 1.00. We'll keep the *Amount* at 1000.
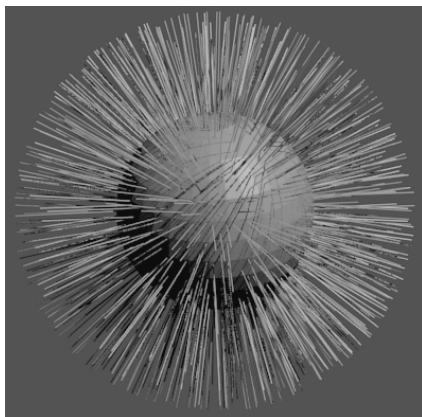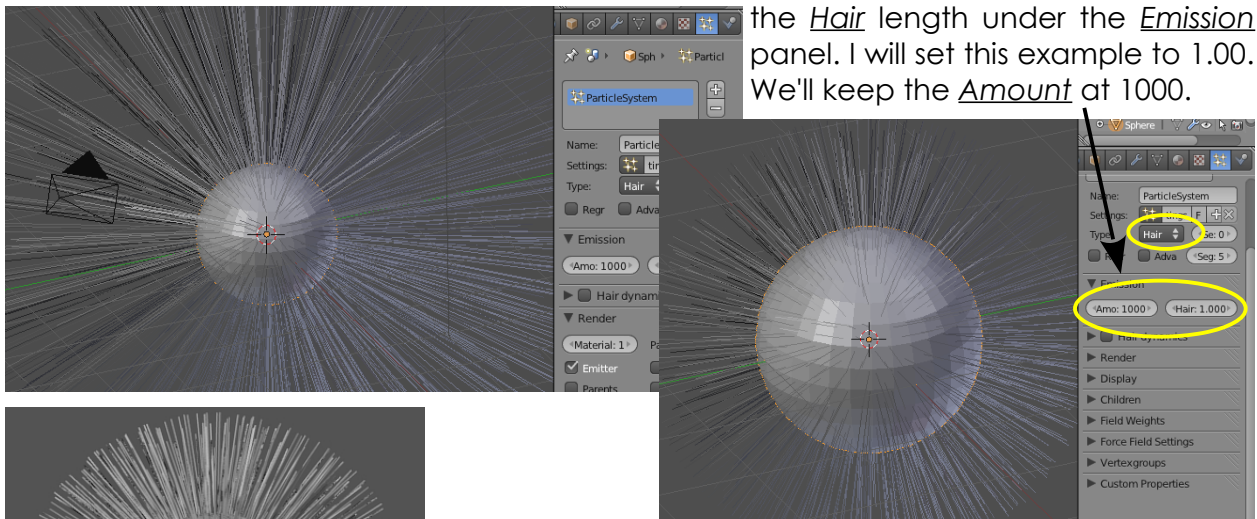
The result should be a render something like the one to the left after reducing the length. There are many settings that can be adjusted, but let's keep it simple. In order to get something more full , random lengths, and effected by gravity, try adjusting the following settings:

Render panel- Adjust the <u>*Random*</u> slider to randomize the hair length.

Children panel- Select "<u>*Simple*</u>", then adjust the <u>*Render*</u> amount to something like 10 for less children. This will fill in the sphere and give more strands without adding more particle hairs to calculate. There are also many more settings for different effects.

Field Weights panel- Check the box at the bottom of the panel "<u>*Use for Growing Hair*</u>" and adjust the <u>*Gravity*</u> low (about 0.020).

These setting should give you a result something like this. Feel free to experiment with other settings.
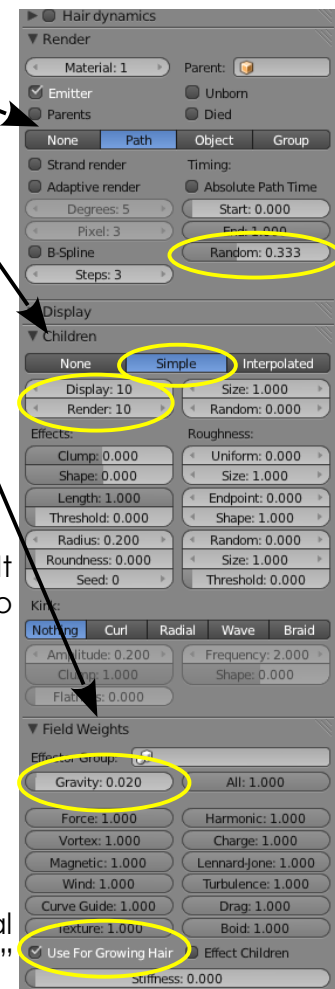
Material Strand Settings:

The shape of the strand can be controlled in the material settings. Put a material on the sphere and open the "<u>*Strand*</u>" panel. Under *Size*, you will see a "<u>*Root*</u>" and "<u>*Tip*</u>" setting. The 1st example uses a Root size of 1.00 and a Tip size of 0.25. This creates a tapered strand. The 2nd example used a Root and Tip setting of 5.00.
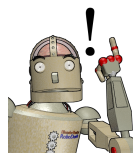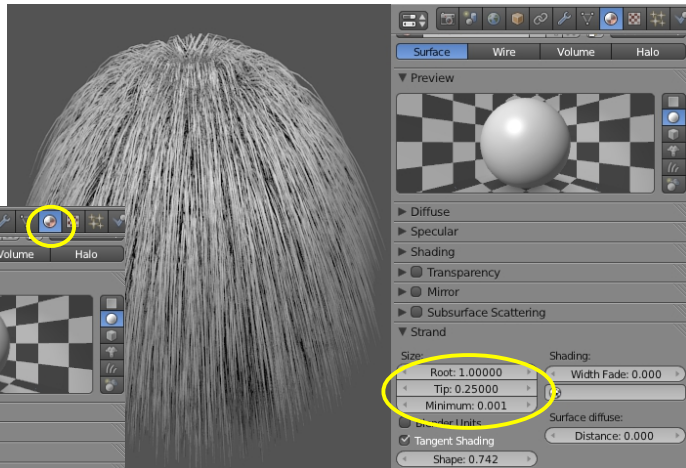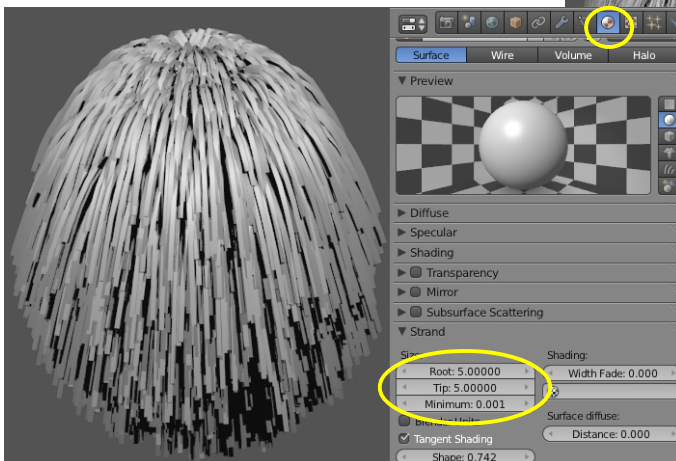
RoboDude Says:
Just like basic particles, force fields like wind can be used to move strands.

Creating and Using Vertex Groups:

You want to make an object with grass or hair, but don't want the particles distributed evenly over the entire object. We can control this with vertex groups that assign different weights to vertices. This example will start with a plane that has been scaled up a bit and subdivided about 5 times in edit mode.
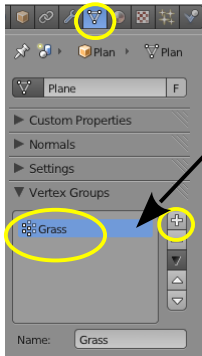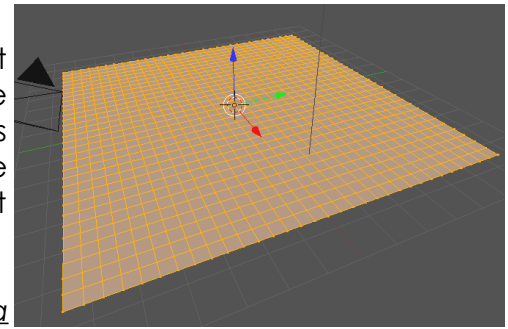
Next, well go to the _Object Data_ buttons and press the "+" button in the _Vertex Groups_ panel to add a vertex group. It might be helpful to change the name from "_Group_" to something more meaningful.

It's now time to assign different weights to the vertices. This can be done 2 ways:

– _Assign weights in Edit Mode_
– _Assign weights using Weight Painting_

Assigning Weights in Edit Mode:

Enter _Edit Mode_, deselect all vertices and select all those that will have the highest density of grass(_use the "B" or "C" key_). In edit mode, you will notice that a few options will show up in the Vertex Groups panel. Take the "_Weight_" slider to 1.000 and hit "_Assign_" to give the selected vertices a weight of 1, the highest density. For areas without grass, assign them a weight of zero, and areas with middle density, a weight in the middle. To see your results, you can change from _Edit_ mode to _Weight Paint_ mode (_discussed below_). Weights will display as different colors.
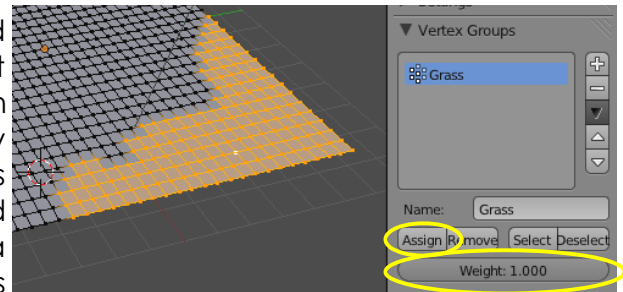
Assigning Weights in Weight Paint Mode:

Weight Painting allows you to "brush" different weights onto your object. You still need to create your vertex group as discussed on the previous page first, then change to _Weight Paint Mode_. Your plane will change to blue (_indicated everything at a weight of zero_), your cursor will be displayed as a circle, and the _Tool Shelf_ will display the Weight Painting tools. Much like assigning weights to vertices, you need to set the _Weight_ you plan to "brush" onto the mesh. You can also set the brush _Radius_ size and _Strength_. The strength determine the fade of the brush. To paint the full weight, set the strength to 1.00.
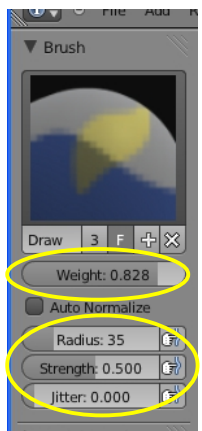
For our example, blue is a zero weight and red is a weight of 1.00. Return to _Object Mode_.
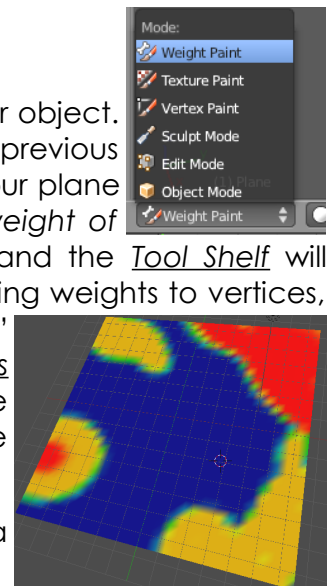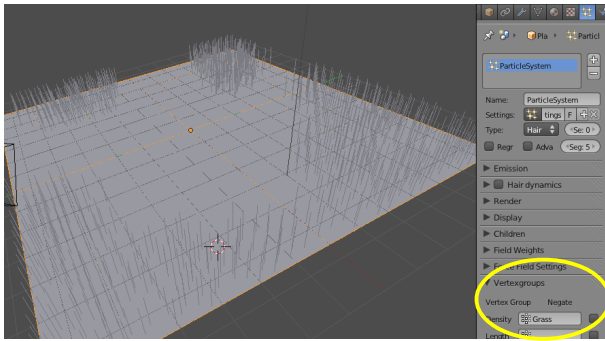
It's now time to apply a *Particle* system and set it up for hair as discussed earlier. In order to make the particles generate using the vertex group we created, select your vertex group for "Density" in the <u>*Vertex Groups*</u> panel. Vertex groups can be used for many other features in Blender.

Other Hair Effects:

We need to discuss a few other options useful for particle hair. These are shaping the hair in <u>*Particle Mode*</u> and assigning colors to the strands other than the main material color of the mesh. Starting with a new Blender file, We will add a Monkey head, set it smooth and apply a *Subdivision Surface* modifier to it. The next step is to add a *Vertex Group*, then enter *Weight Paint* mode and brush weighted areas where you wish the hair to grow. Painting may be difficult due to the monkey not having may vertices. My example is shown to the right with the monkey having a Goatee and a Mohawk:

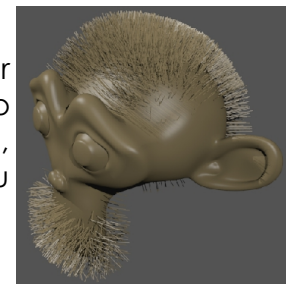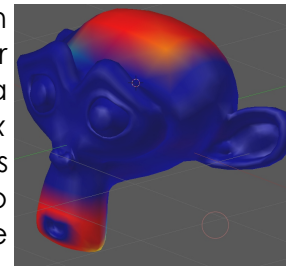Now go to the *Materials* panel and put an appropriate color material on the monkey. I used a brown color. The next step is to apply a hair particle system as previously discussed. Set hair length, amount, and children to desired appearance. At this point, you should be able to render an image and see results similar to these.

Looks good, but I would like to have the hair a different color. To do this, go back to your *Materials* panel and click the small "+" to the right of the materials list. Give it a name in the block below it and set the diffuse color. I chose a shade of yellow. The material list will show 2 materials set for this object. The 1st material channel is used for the mesh color while we will use the 2nd material channel will be used for the particles.

Now go to the *Particles* panel and find the *Render* settings. You will see a block where you set the particle material. Set it for <u>*Material 2*</u>. This should force Blender to use your second material for the strands. Hit F12 to render an image and you should see something like this:
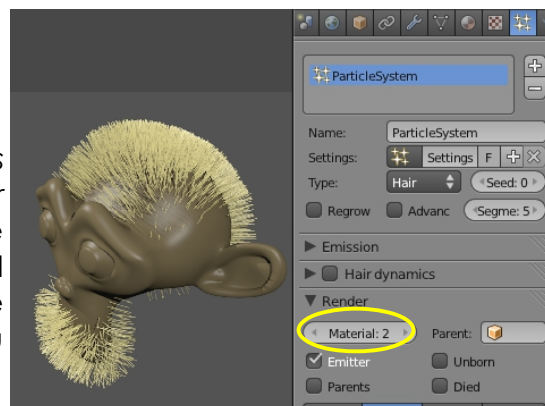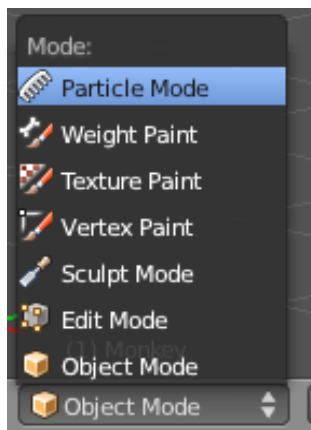
It's now time to comb and shape the monkey's hair and beard. Switch from *Object Mode* to *Particle Mode*. A new set of options will display in the Tool Shelf. By default, you may only see the original strands without the children on the screen. You can check the "*Children*" option at the bottom of the Tool Shelf. Experiment with the different options available in Particle Mode. By using the Comb, Cut, Smooth and Puff commands, you can modify the hair quite a bit.
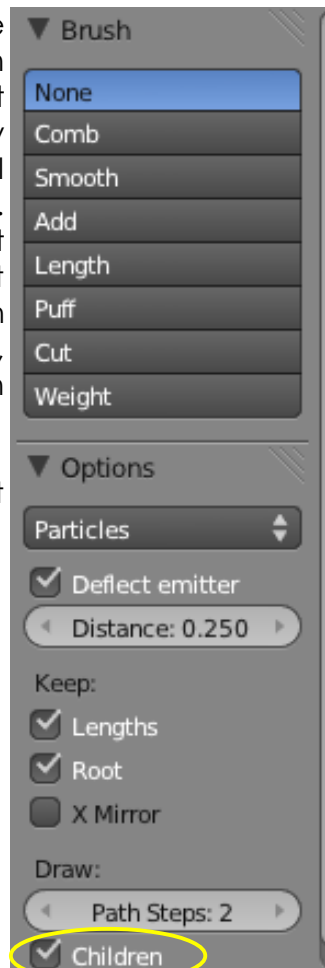
With a little practice and patience, you can create some great effects!.
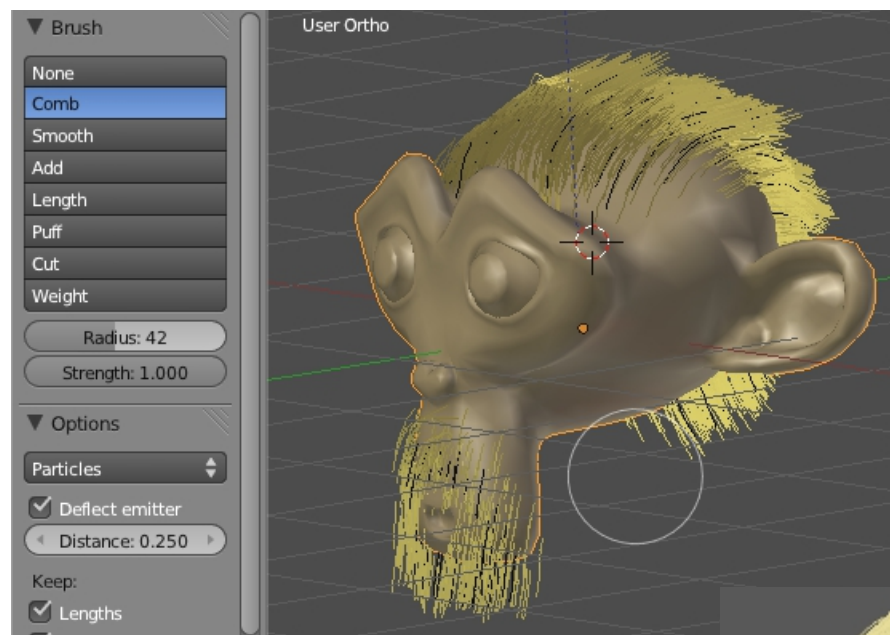
To summarize the particles unit, by adjusting the basic settings discussed here and experimenting with others, you can use particles for a variety of effects in your scenes. Need a dusty, blowing scene? A fire with flames and smoke? Grass blowing in a field? By browsing the forums, you can always find someone doing something new.

Adding Rain to Your Scene

Now it's time to add some rain to your stormy night. Open up your "***Landscape Scene***". Start by adding a *plane* in the top view and *scale* it up a bit larger than your ground. Move it up high enough so it is not visible in the camera view. While in edit mode, select "***Subdivide***" in the Tool Shelf and set "***Number of Cuts***" to **20**. Returning to Object mode, your scene should look something like this:
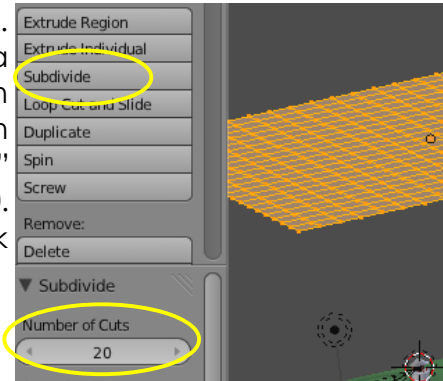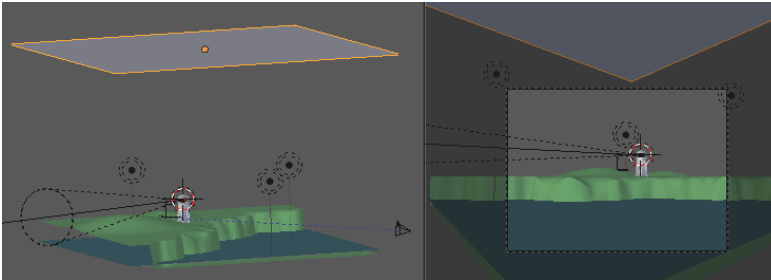
Now it's time to add a "Particle System" to make it rain. Since we want it to be raining at <u>*frame 1*</u>, we need to start the rain at some point before that (*-100*). We also want the rain drops to last the entire animation (lifetime), be random, and appear to be effected by the wind. Try these setting. Press "***Alt-A***" often to check your results (*remembering to always be on frame 1*). Place a dark gray diffused material color on it for a dark, rainy look.

Number: 30000; Start: -100; End: 200; Random Distribution
In <u>*Velocity*</u> panel, Y: 4.000 for side movement
In <u>*Render*</u> panel, switch to Line. You can adjust the length of the line with the "<u>*Tail*</u>" / "<u>*Head*</u>" settings.

Since your scene may be a bit different, feel free to adjust these as desired.

This is a pretty simple rain effect, but quick and easy for our scene and works well. Experiment with material setting for a nicer look. When finished, render an image and save it as a png (F3). If time permits, feel free to animate your scene.
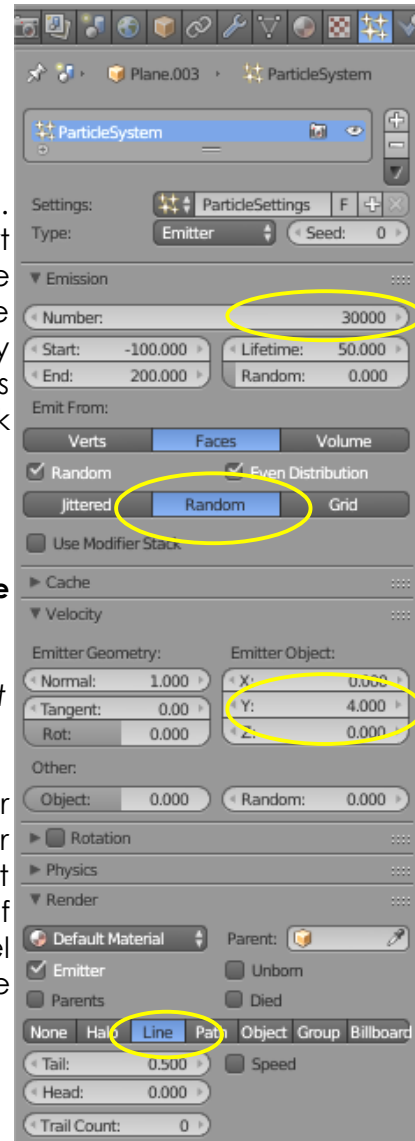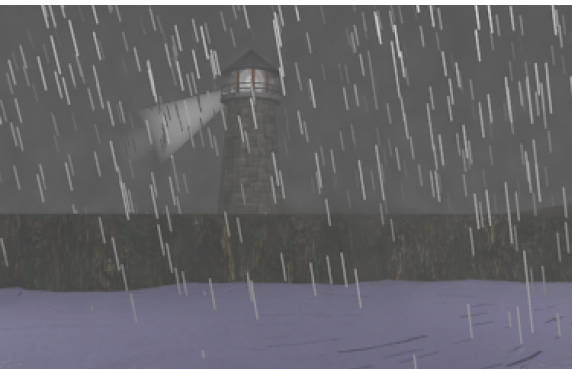
*** Call the instructor when finished**

Fireworks Display:

Now that you have some experience using particle systems, try to create something challenging and realistic- a fireworks display. Watch some online videos of fireworks to determine exactly what you see and need in a system. Do you see a trail following up from the ground? Is there smoke? Do you see multiple colors in a single firework? How about the background (world) settings?

Determine how many different fireworks you want to create and the timing of the particles. Create an animation of your scene when finished.
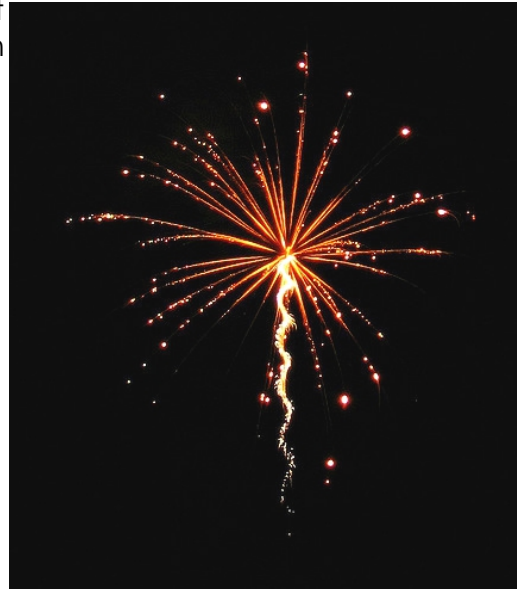
Candle with Particles:

Alternate Activity: Create a simple flame using particle systems for a candle. Like the fireworks activity, examine images and videos of how a flame actually burns. You will need multiple particle objects just to create one flame. Is there a smoke trail? What colors do you see in a flame?

Create an animation of your scene when finished.

*** Call the instructor when finished***

Chapter 14 Reflection and Wrap-up:

Program Interfaces and User Reactions

You have seen that particles can be used to represent a lot of effects in a 3D model. Take some time to reflect on your experiences by answering these questions.

1. **Blender particles received their best development during the creation of the Blender open movie, "Big Buck Bunny". Search YouTube for "Big Buck Bunny" and examine the particle effects used for grass and fur. What do you think? How does it compare with other professionally animated movies? What works and doesn't work? Explain.**

2. **How could particles be used in a space movie for force fields and phaser beams? How would you attempt to use them? Explain.**

3. **For the lighthouse scene, you attempted to create a rain storm. How could you create a snow storm? Explain.**

Using Child-Parented Objects

So far, we've talked about making and editing objects, making them look good and how to render and animate them, but how do we make things like humans or robots or anything else move about that have *several parts connected together*? This is where **child-parent relationships** become useful. It allows us to link things together without actually joining them. This allows the individual parts to move about, but still follow a "master" object.

The concept of child-parent relationships is used in all animation programs and it involves an object assigned the role of a **child** and an object assigned the role of a **parent**. If the *parent* moves, rotates or scales, the **child** must do so too. **On the other end, a child can move, rotate or scale without affecting the parent.** An example would be: a *hand* is the child of the forearm while the *forearm* is the child of the upper arm and the upper arm is the child of the torso. Therefore, if the forearm moves or rotates, the hand must follow and if the upper arm rotates, the forearm *and* hand both must follow. If the torso moves, the entire arm must go with it. This is how you keep a body or machine from going to pieces!

In order to make child-parent relationships in Blender, you need to hold down the "**Shift**" key to select multiple objects. *Select the child object FIRST, then select the PARENT object.* The child object is always selected first. If you have a string of objects that need to be child-parented together (like the arm example), *you can only do 2 parts at a time so start at the end of the chain and do the hand and forearm first, then forearm to upper arm and so on*. After selecting the 2 objects, press "**Ctrl-P**" and select "**Object**" to make parent. You will see a dashed line drawn between the pivot points of the 2 objects. This shows a child-parent relationship.

Child Object- Selected First

Set Parent To
Object   Ctrl P

Parent Object- Selected Second
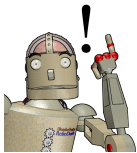
> ***RoboDude Asks: I did the Child and Parent selection backwards- How do I undo them?*** *In order to delete a child-parent relationship, select both objects and press "Alt-P" to clear parent.*
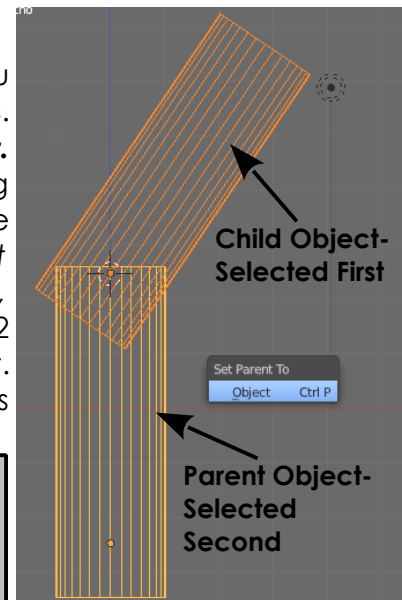
Look at the example on the next page. If we want to child-parent a few cylinders together to make a robot arm, create a cylinder and stretch it out in edit mode by moving one end of vertices. ***Remember to pay close attention to the object's pivot point***. If the object needs to pivot like an arm, you will need to keep the point at one end of the cylinder. *Always pay close attention to the object's pivot point in any case. It's easy to forget about it when moving vertices around in edit mode*. We'll look at moving center points next page. After you shape one cylinder, exit edit mode and press **"Shift-D"** to duplicate. Locate the cylinders and double check their pivot points. **We want to make sure center points are correct before child-parenting.** Start at the end and select the first 2 objects. Press **"Ctrl-P"** to make the relationship. Check it out to see if it's correct and go to the next set. In the next set, the previous **Parent** object now becomes the **Child** object. Make a simple animation to check the function.

Chapter 15- Child-Parent Relationships

**Object Origins
(center points)**

Parent Object

Set Parent To

Object   Ctrl P
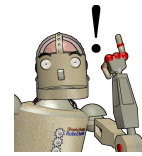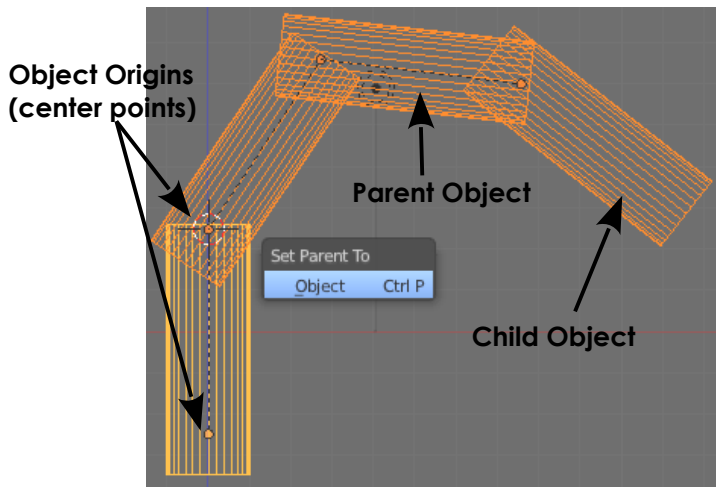
Child Object

RoboDude Says: You can child-parent almost any object including cameras, paths, empties and lamps. Great for keeping a camera attached to an object!

Adjusting Object Origins (center points)

In the basic editing chapter, we discussed how to move origins (center points) of objects. You were also cautioned about moving an object while in edit mode because the vertices will move, *but not the object's center point*. To move the center point of an object, **select the object**, place the **3D cursor** (LMB) in the location you want the center point to go, and find the "***Origin***" button in the *Tool Shelf*. You will have 4 options:
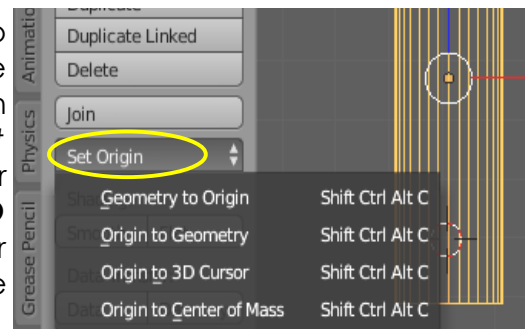
"Geometry to Origin" *(centers the mass around the object's current center)*
"Origin to Geometry" *(moves the center point to the object's shape)*
"Origin to 3D Cursor" *(moves the center point to the 3D cursor's location)*
"Origin to Center of Mass" *(moves the center point to the object's mass)*

In order to find a precise location, don't forget about the "**Shift-S**" command to snap to locations. It is useful for finding exact locations of object or selected vertices. Also useful for moving things around in 3D space. The *Shift-S* command is useful for finding an exact location to move the cursor, then assigning the object's origin to the cursor's location.
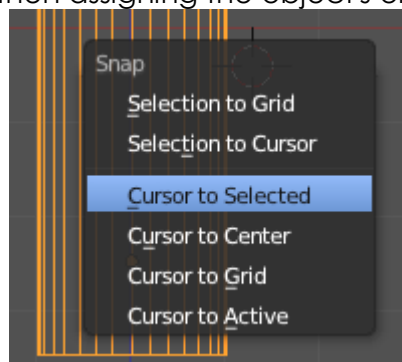
Create a new Blender scene and set up the views any way you wish. **Your job is to design a robotic arm that is child-parented together and animated**. Create all components using planes, cubes, spheres and cylinders. Locate your object origins to good logical pivot points. Place materials on all objects and develop a good scene with plenty of lighting.

After you create your scene, develop a 150 frame animation of your robotic arm moving in all directions.

Difficulty Bonus:
Try to make your robot arm pick something up off the plane!

Helpful Hint:
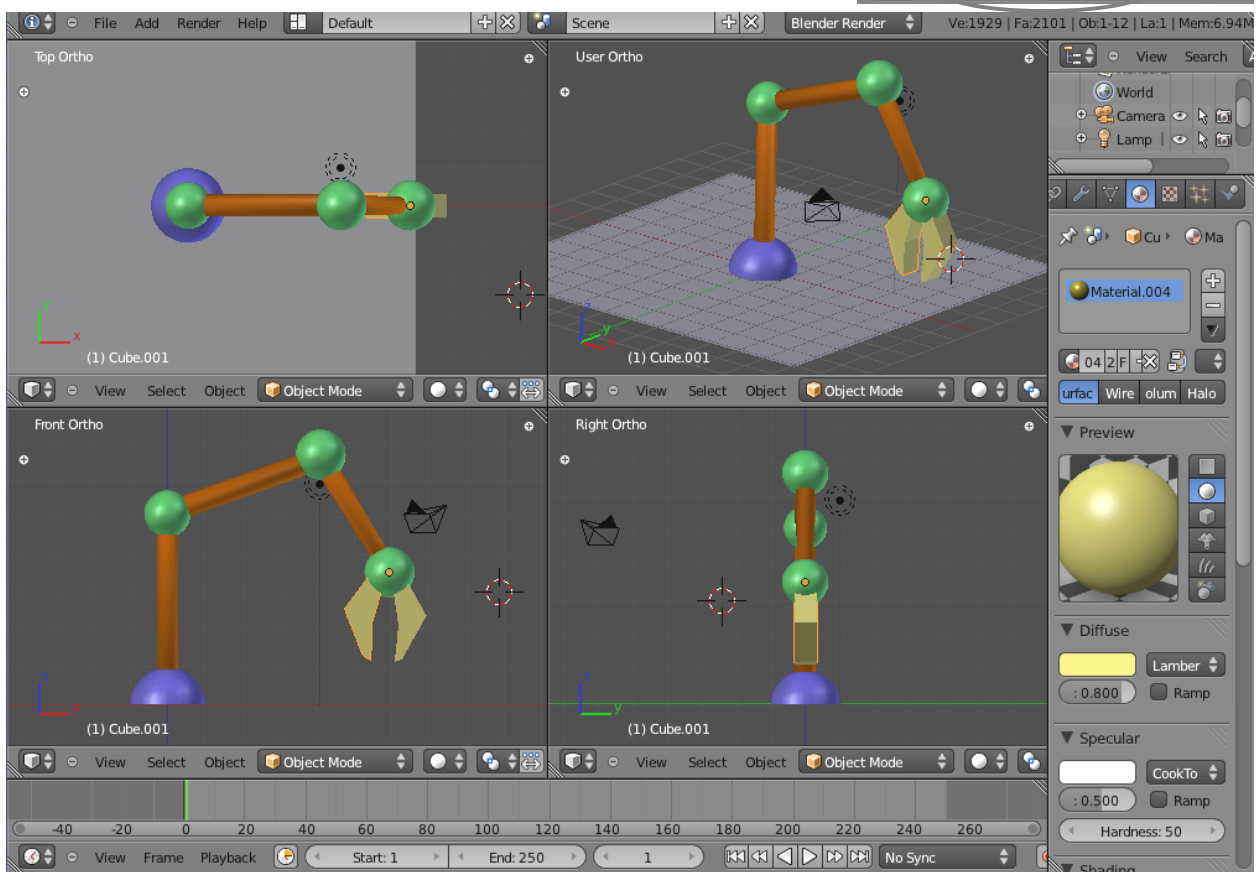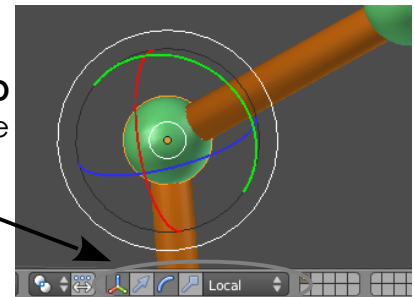When animating, it may be useful to turn on the **3D Widgets**, switch to *Rotation* and set it to *Local*. It will make setting animation keys much easier!

** Call the instructor when finished**

A Simple Character:

For this challenge task, create a robot or humanoid character using child-parent relationships to connect the body parts. The character does not need to be too complex, but be able to walk and pose. Use and edit cubes, spheres, cylinders, etc. to shape the character. Pay close attention to the locations of the pivot points. Add a scene for your character and appropriate materials and lighting.
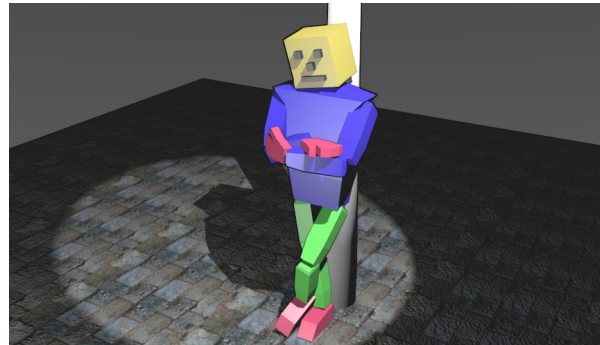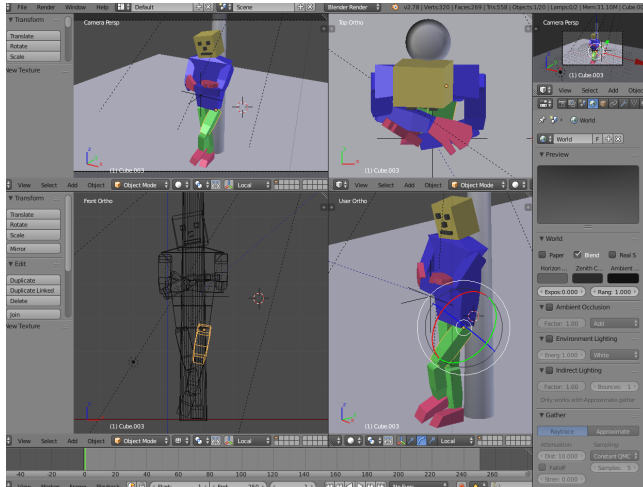
*** Call the instructor when finished***
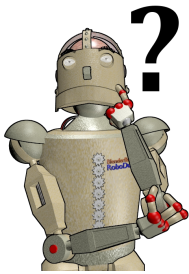
Chapter 15 Reflection and Wrap-up:

Parenting Objects

The ability to be able to animate a child after it has been parented to another object remains a strength in any animation program.

1. **Try to child-parent an object to two different parents at the same time. What happens? Why do you think Blender won't allow you to do this? Explain.**

2. **Think about a spinning object with layers, like a gyroscope. How would you child-parent and animate the model? Explain.**

3. **Think of a model that would benefit from child-parenting that we haven't discussed yet. What could you use this for? Explain.**

PERFORMANCE TASKS

Constraint Basics

Like *Modifiers* discussed back in chapter 13, *Constraints* are provided to help with animation. Like many other Blender features, constraints have changed considerable from previous versions and are divided into 3 main groups- *Transform, Tracking, and Relationship*. Some of these we have already used through key commands like *Track To* (Ctrl-T) and Child Of (Ctrl-P).

In this chapter, we will focus on some of the basic constraints like tracking to various things and working with paths.

Transform Constraints:

Copy Constraints:
You can copy the location, rotation, scale, and transforms from one object to another using these constraints. You select the *Target* object to copy from, select the axis (or inversions) and choose to use world or local space for the axis reference.

Limit Constraints:
Like the copy constraints (*location, rotation, scale, distance*), you can set axis limits for motion on an object. Great for giving an object limited motion or motion on a specific axis.
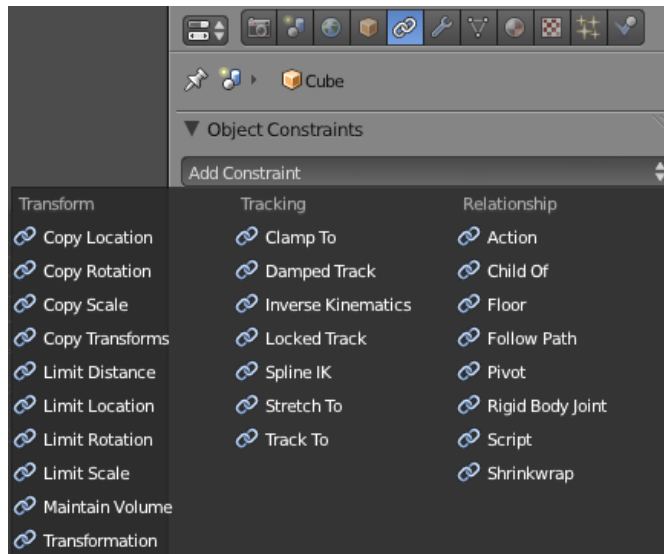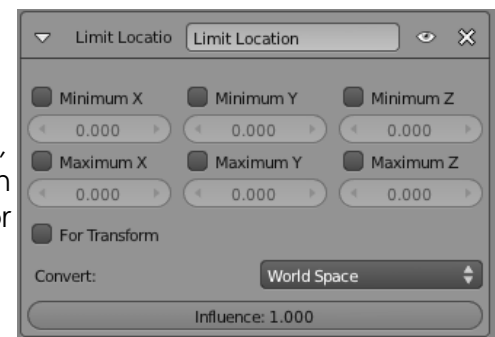
Tracking Constraints:
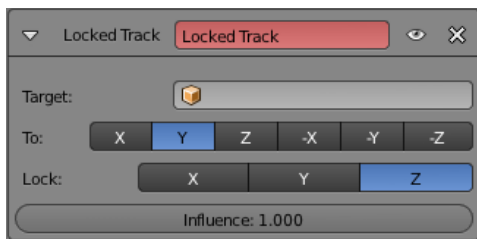
Tracking Constraints:
There are several different tracking constraints that give slightly different options relating to how an object follows a target and if an axis stays upright at all times. In past chapters, we have accessed these using "Ctrl-T".

Armature Constraints:
There are several constraints in this category related to Armatures that will be discussed in a later chapter (*Inverse Kinematics, Spline IK*).

Chapter 16- Working With Constraints

Relationship Constraints:

Child Of Constraint:
Works exactly like what we did in the previous chapter, but with visual controls.

Locking Relationship Constraints:
Several other constraints in this category lock to another object such as providing a floor level, providing a pivot point and following a path.

Tracking To An Object

There are times you want to "*constrain*" or "*follow*" a certain object in your scene. New constraints are being developed in Blender, but for now, we will just be talking about the most common one used to keep the camera focused on an object- *the "Track To" constraint*. The tracking constraint is useful in animating by saving you a lot of time and frustration trying to place location and rotati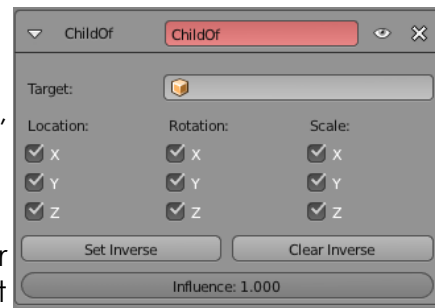on keys on the camera in an effort to try to keep your target centered. When used in conjunction with *Paths* (discussed in this chapter), you can create very smooth animation paths. *Objects besides cameras can also be used with tracking.*

To set up a simple camera tracking constraint, Select the *camera* first, then the *target* while holding down "*Shift*". Press "*Ctrl-T*" and select "*Track To Constraint*". Sometimes it's convenient to target an *Empty* object (created in the *Add* menu, like we used in the lighthouse scene). This allows you to move your target around in your scene so the camera can focus on one object for a while, then move to something else by moving the target in that direction. You also have an *influence* option where the camera will track solidly to the object or allow some flowing of the camera.
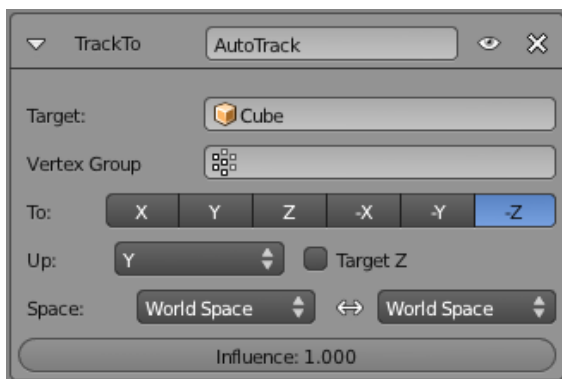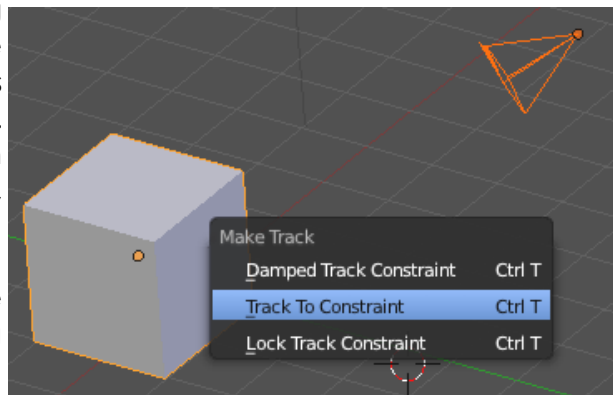
The other way to apply the *Track To* constraint is through the *Constraints* panel discussed in this chapter. However, by pressing "Ctrl-T", this constraint will automatically be placed in the stack. You can even choose to follow a vertex group, lock to specific axis and space, and even choose the amount of influence of the tracking.

A Camera That Follows The Arm

Open the Robot Arm scene you made in the last exercise and add a camera constraint. You may target any part of the robot arm you like or create an Empty and target the camera to that. In the scene below, the camera was targeted to the gripper head. In the *Object* properties panel, I renamed the sphere on the gripper head to head. If needed, experiment with the axis settings to get the camera to pint to the object.

After you create your scene, develop a 150 frame animation of your robotic arm moving in all directions with the camera also doing some movement.
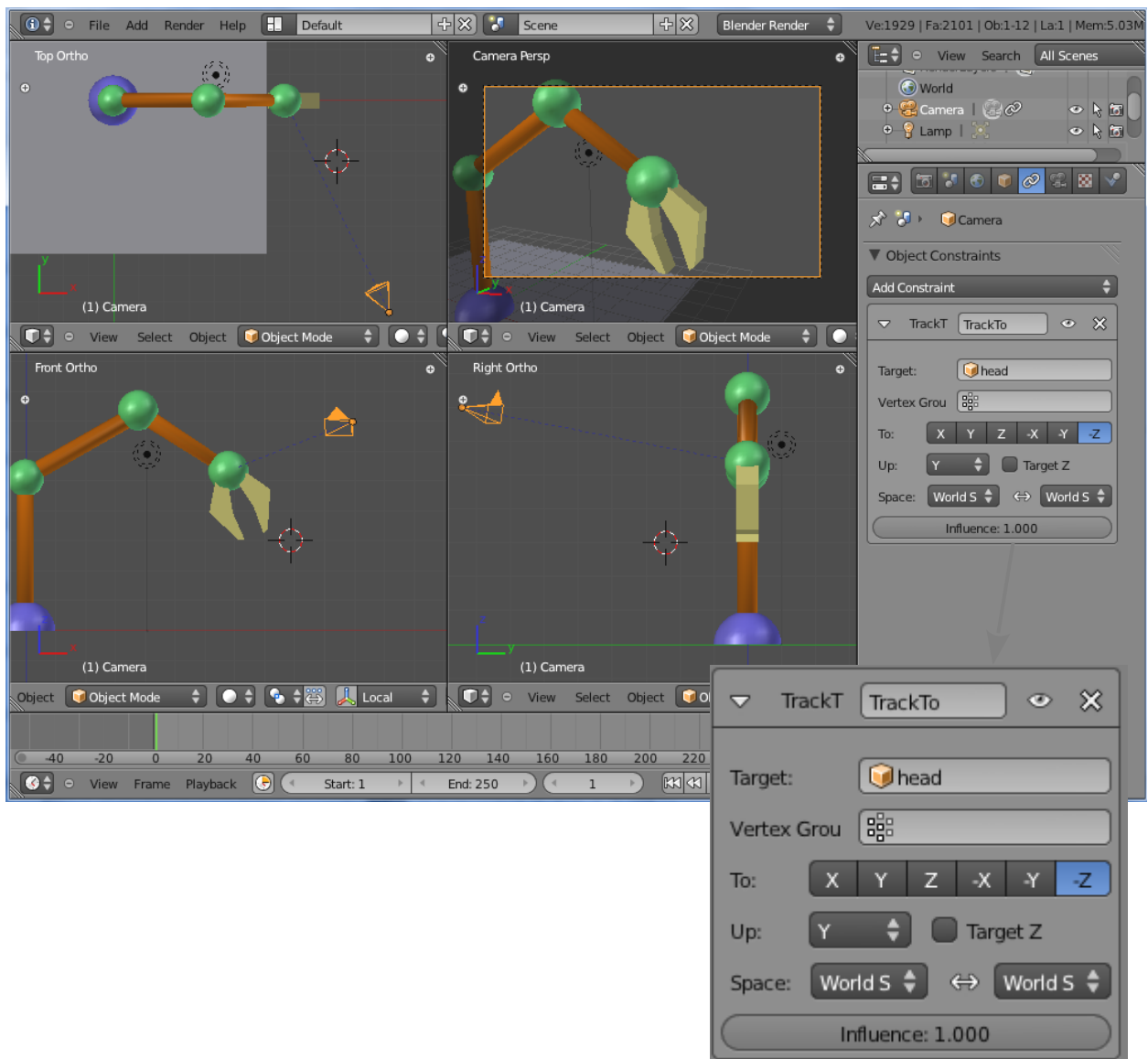
*** Call the instructor when finished***

Following Paths and Curves

Sometimes, you need to have an object flow along a smooth path in an animation. For example, it would be easier to have a spaceship flow along a line that angles and banks along that line then it would be for you to insert location and rotation keys throughout the animation. *Paths and Curves* are found in the same *Add* menu and can not only be used to create animation paths as discussed above, but can also be used to create extrusions. To create 3D extruded objects, you need to create a 2D sketch of a profile and a path for that shape to follow along. In this chapter, we will be working with both.
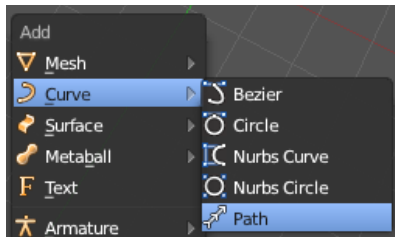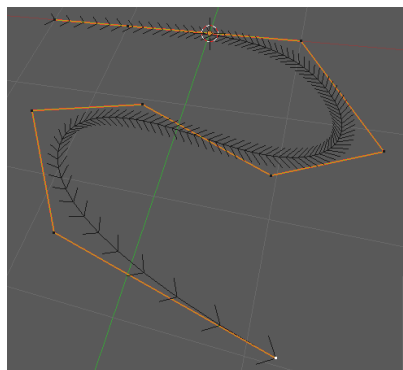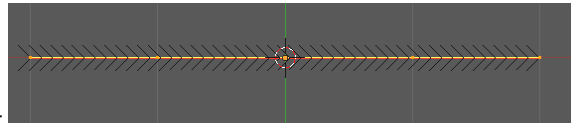
Following Paths:

Your first step is to create a *path*. Any type of **Curve** in the **Add** menu can be used as a path, but let's use the *Path* option. Hit the *"Shift-A"*, select **Add, Curve**, then **Path**. You will then get a path on the screen. Enter *Edit mode* and you will see several points and arrows pointing the direction of the path. You will also see some options in the *Tool Shelf* related to the path, including *"Switch Direction"*- useful if you shape the path in the wrong direction and find out after you place the camera on it. Shape the path as desired, add more vertices through *Subdivide* if necessary and exit *Edit* mode. You can also select an end point and use "*E*" to *Extrude*.

There are several ways to get the camera, object or lamp to follow the path. For now, we'll stick to the traditional way by creating a *Child-Parent relationship*. Select the object first, then the path (the parent). With both objects selected, press **"Ctrl-P"** to make a parent. You'll see several options- select the *"Follow Path"* option. You will see a dashed line between the 2 objects. Press **"Alt-A"** to see the animation along the path. In order to get the object exactly placed on the line, move the object and place it. Rotate the object to point in the correct direction as well. Right now the object's animation is exactly 100 frames long. To change this, make sure the path is selected and go to the **Object Data** buttons. here's what you see:
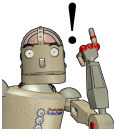
Frames- Adjust the time it takes to traverse the path.

Follow- If selected, the object will rotate as it follows the path. If not selected, the object will follow, but not curve.

> *RoboDude Says: You can <u>close a path</u> to make it a continuous loop.*
> *While in Edit mode, select the 2 end point and press "F" to fill the object. The path will now be closed.*
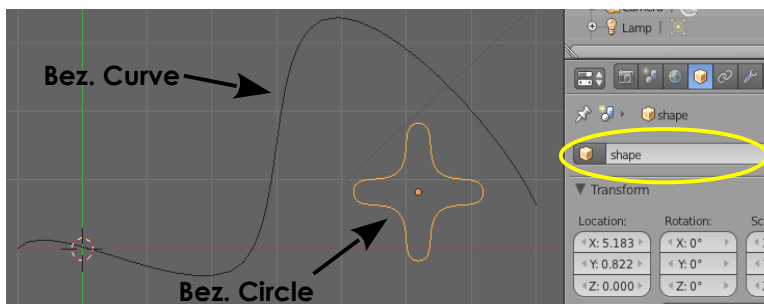
Sometimes you don't want the camera to follow along the path, but look at an object as it flows along the path. **This is where you would want to use the *Path*, but not the *Follow option.*** Instead, you would put a <u>*Track To*</u> constraint on the camera so it looks toward an object (empty) as it moves along the path.
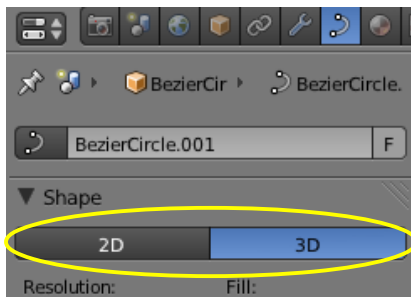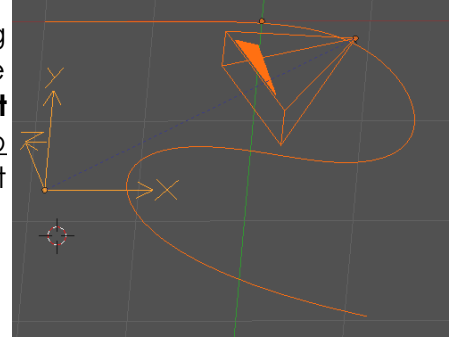
Other *Curve* objects can be used as paths also. For example, if you want a circular path, select the <u>*Bezier Circle*</u> option from the *Curve* menu. **If the circle appears filled when rendered (F12), change it from 2D to 3D in the Object Data panel.**

Using Curves for Extrusions:

You can create a shape and extrude it along a path in Blender. For our example, we will shape a <u>*Bezier Circle*</u> and extrude it along a <u>*Bezier Curve*</u>. First, create a <u>*Bezier Circle*</u> from the **Add-Curves** menu and shape it into an interesting object. Feel free to add more points with the *Subdivide* command. Second, create a <u>*Bezier Curve*</u> and shape it into some shape. Bezier shapes form differently and use spline points. Experiment with them to get the feel of working with them. Go to the *Object* panel and name both objects in the data block.
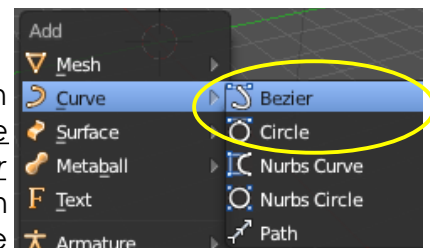
Bez. Curve

Bez. Circle

Finally, select the <u>*Bezier Curve*</u> and go to the *Object Data* buttons. You will see a **<u>Bevel Object</u>** box in the *Geometry* panel. Select the circle object. You will see the shape extruded along the curve! You can still shape the circle and the curve (*in edit mode*) and scale the objects. Play with the <u>*Resolution*</u> setting in the Shape panel on both curve objects and hit "Alt-C" if you wish to convert it into a mesh.
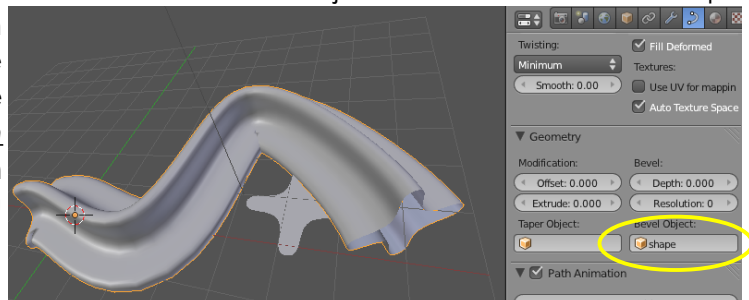
Challenge Task- A Simple Rollercoaster

For this exercise, you will be using paths and curves to create a roller coaster track. Start with a new Blender file and create a *Path* from the *Add-Curve* menu. Shape it in both the front and top views so you have curves and hills. Close the path by selecting the end points and pressing "**F**" to fill.
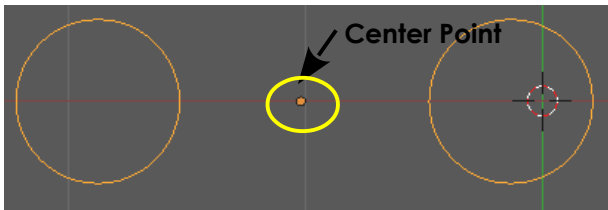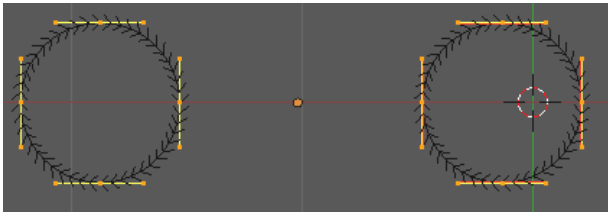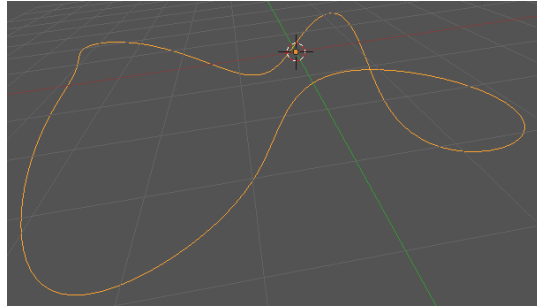
Now add a *Bezier Circle*. Scale it down about ½ size, enter **Edit Mode** and move the entire shape to the left of it's center point. Press "*Shift-D*" to duplicate the circle (still in Edit Mode) and move it to the opposite side of the center point. These will be extruded as the track rails. Return to *Object Mode*.

At this point, select your *track* and hit "*Shift-D*" to duplicate it once.

Center Point

With one track selected, go to the *Object Data* panel and select the circle object under the "*Bevel Object*" option. You may need to select the circle object and scale it down considerably for it to look right. You may also need to enter *Edit Mode* for the track and use "*Ctrl-T*" on some points of the curve to *twist* them to a better curve.
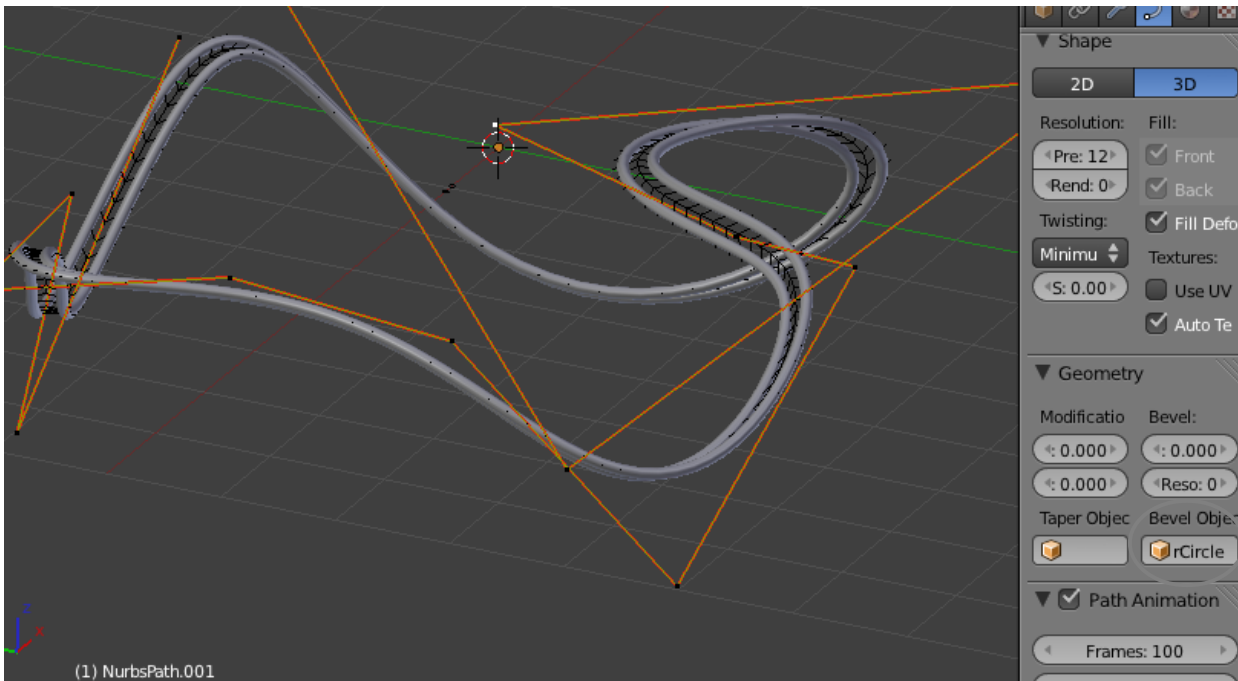
If the rails are not centered over the path, the Circle's center point may not be directly between the 2 circles. If so, correct the issue.

Now, select the other path that you duplicated earlier and move it up slightly so it is easier to select. Select the _Camera_, then this _Path_. Hit "**Ctrl-P**" to make a "_Follow Path_" constraint. A dashed line will display between the two objects. It may take some time to get this correct, but move the camera to the dashed line's contact point. Adjust the camera angle and test the animation with "Alt-A". Experiment with this until you are satisfied with the animation. If it is too fast, adjust the curve settings in the Object Data panel.
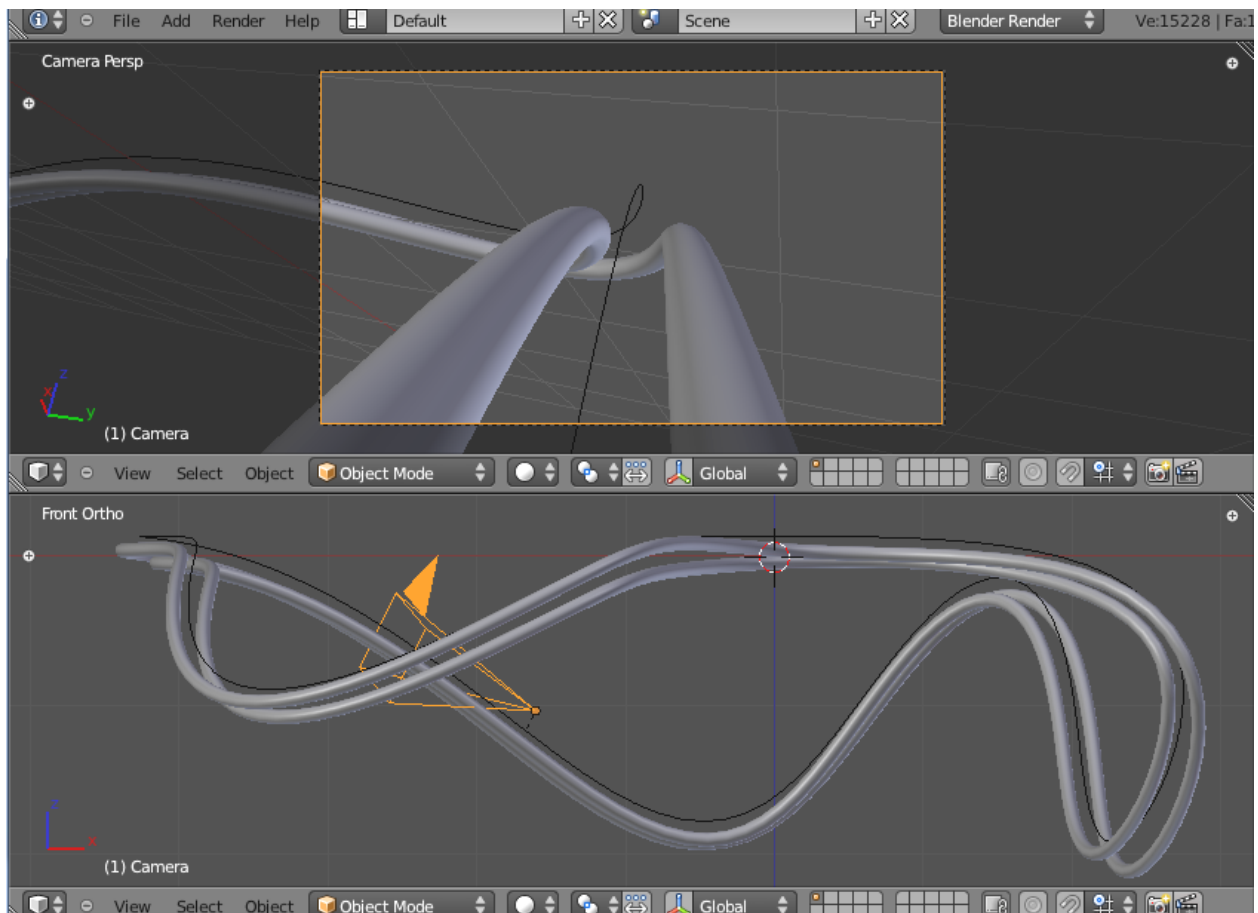
Add a world to your scene and animate a 100 frame movie.

Extreme Challenge Exercise:

Duplicate the curve one more time and extrude walls around your coaster to make it into a mine tunnel. Add textures and animate. To duplicate a mesh along a path, create a mesh object and child-parent it to the path. With the mesh selected, set **Duplication** to "**Frames**", "**Speed**" off. Select the curve path and adjust the frames to get the correct number of duplicates in Object Data.
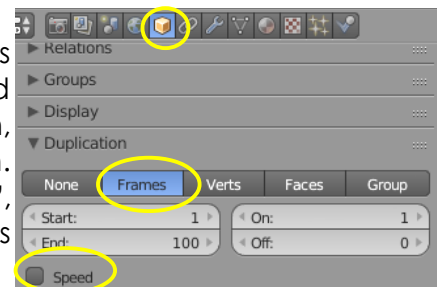
_ Call the instructor when finished**_**

? Chapter 16 Reflection and Wrap-up:

Constraints and Paths

In this chapter, you experiences some of the constraints that are available to simplify your modeling and animation process. Take a few moments to reflect on these questions.

1. Take a look at the "Copy" and "Limit" Transform Constraints. These constraints are great to have objects copy the motion of other objects or limit an object's motion. Explain at least two examples of where these features could be useful.

2. In the extreme challenge portion of the roller coaster track activity, you have the option to try to add mesh objects along a path. How could you use this feature, and the path extrusion feature, to create a mine tunnel ride? If necessary, find an example on the internet. Explain.

3. Research the internet, or draw from personal experience, where one of these constraint features may have been used in a professional movie. What did you find? Explain your example.

Using Armatures to Deform Meshes

Blender's animation capabilities are great for most object animation except when you want to animate something bending like a person in motion or a tree bending in the breeze. This calls for a mesh to deform which can't be done with traditional modifiers. We can deform a mesh in 2 ways in Blender. One way is to create a skeleton and have it deform a mesh *(armatures)* and the other method is to move the mesh vertices in edit mode and create sliders that deform the mesh *(vertex keys)*. This chapter deals with creating armatures. The armature feature in Blender is constantly under development. For this discussion, I will stick with the fundamentals. More information can be found at www.blender.org or at www.blenderartists.org.

The first thing you need to do is create a mesh that has a few groups of vertices where you would like the object to bend. Any mesh will work and to get additional vertices you can either **extrude or subdivide**. *Be careful not to create too many vertices.* It may slow your model down considerably. Let's use a cylinder to create an arm. I will use a cylinder set at the default divisions of 32. Next, I will change to a front, ortho view and box select the top set of vertices and *Extrude* them up. I prefer to use extrude rather than subdivide to keep the vertex count down as low as possible. As I extrude the vertices, I am also using *Scale* to shape them.
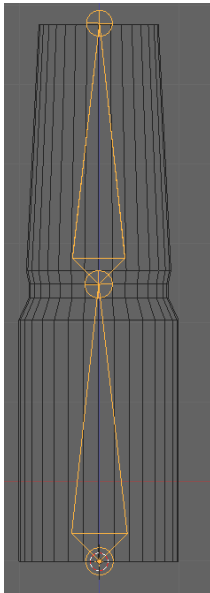
Next, place the 3D cursor directly at the bottom of the shape you just made. Hit "*Shift-A*", to add an "*Armature-Single Bone*". You will immediately see a bone begin to form at the cursor location. Enter *Edit Mode* and type "**G**" to *grab* the top of the bone and lengthen it to a desired size. Move your cursor up to lengthen the bone and click where you would like the joint to be. To create another bone at the top of the first one, press "**E**" to *extrude* another bone from the first one. If you run out of room to drag the mouse up, just click wherever and hit "**G**" again to move the end. To always adjust bones, you must be in Edit mode. Also, make sure you have the end of the bone select and not the entire bone. When finished, press *Tab* to exit edit mode. Double check the armature to make sure that the ends and joint are well aligned. To add more bones, enter edit mode again to extrude with the end bone selected.
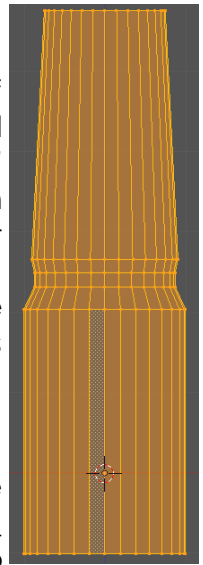
Your next step is to create a <u>Child-Parent</u> relationship between the mesh and the armature with the mesh being the <u>Child</u> and the armature being the <u>Parent</u>. While holding the *"Shift"* key, select the mesh first, then the armature. Press "*Ctrl-P*" to make parent. Select the option "*Armature Deform*" and "*With Automatic Weights*" so the computer will figure out which vertices to deform to which bones. If it's not right, we can fix this later.
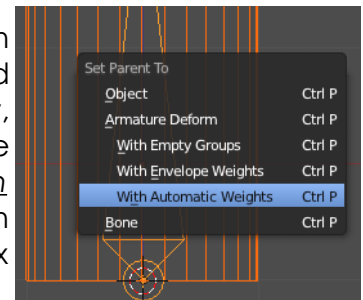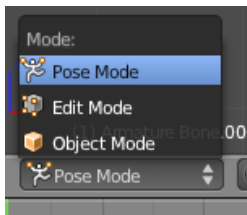
To test the armature system you just created, select the armature only and switch from *Object* mode to *Pose* mode. Right-click on the top bone and rotate it. It should deform the mesh as you rotate the bone. By rotating the lower bone, you will rotate the entire mesh.
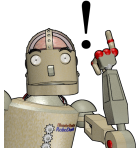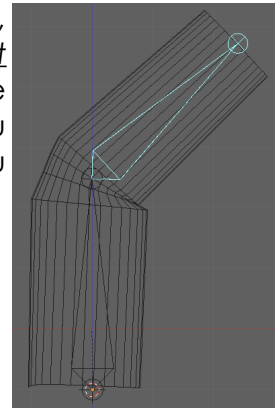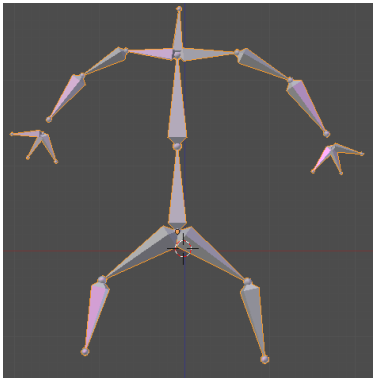
RoboDude Says:
If you ever need to return to edit mode for the mesh or the armature after posing, they will temporarily return to their un-posed states.

Creating Complex Armature Chains:

Extruding bones as we did works well for simple chains, but if you want to make more complex chains and skeletons, you'll need to know a few more things then just extruding from the end of a chain. You will notice that the 1st bone you created is the master parent for the system and you can also extrude from the bottom of that bone. The problem is that, in *Pose* mode, this bone will not be automatically parented to the master bone. You can also make entirely different armature chains, then *Join* them together using "*Ctrl-J*". In pose mode, these will also not function with the entire system. So how do you correct these child- parent issues?

First, you need to know the *Name* of each bone. In Pose mode, you can RMB click on a bone and the name will display, but you can have all the bone names display on the screen if you turning on an option in the *Object Data* panel (*now displayed as an armature*). The example shown consists of 2 different armature objects that have been joined together in *Object* mode using "*Ctrl-J*". When you enter *Pose* mode, they do not move together. In the *Display* panel, you will see an option to display the names on the screen. You will also see some options to change the way the bones look. To correct the parenting issue, go to the *Bone* panel, enter *Edit* mode and find the option for *Parent*. Select the bone you wish to parent to.
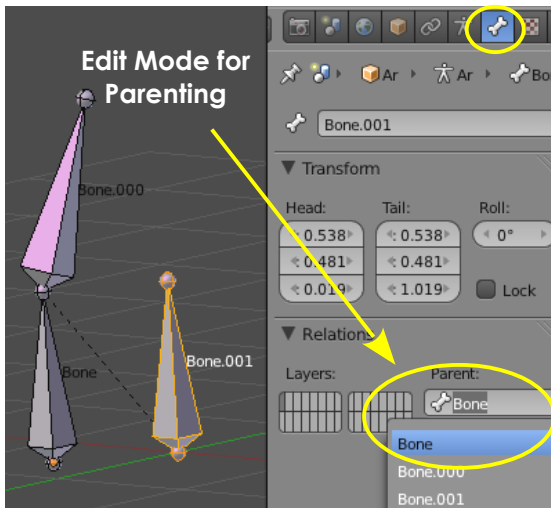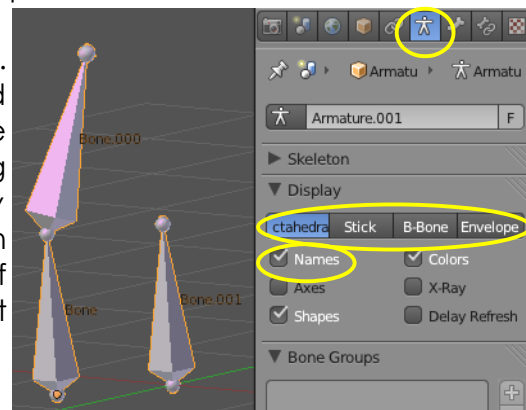
Edit Mode for Parenting

Animation Tips:

When animating an armature, there are a few techniques that can make your life easier and were discussed previously in the animation chapter, but will be reviewed here. Since you have so many bones to animate, it makes sense to use the <u>*Automatic*</u> key-frame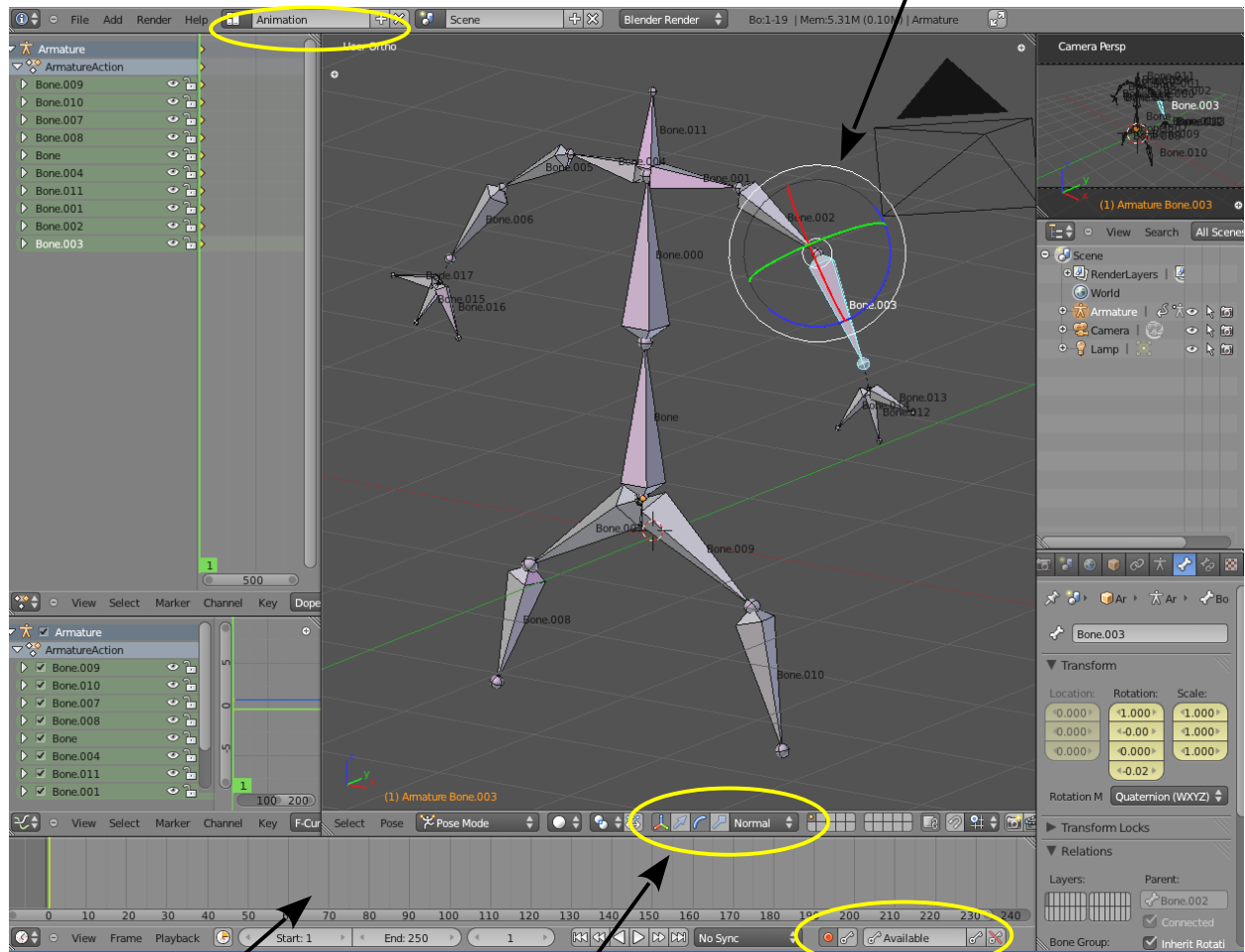 feature. It is also helpful to use the <u>*Rotation*</u> transform manipulator and the time line to advance through time. It may be helpful to review the chapter on animation for assistance. Below are some of the basic setting that we use for animating armatures:

Screen Layout:
Switch to animation

Rotation Widget:
Makes rotation easier

Time Line:
Can move to key-frames quickly with controls

Transform Widgets:
Turned on, set to <u>Rotation</u> and <u>Normal</u> alignment. Used to rotate bones by grabbing the right axis.

Automatic Key-frames:
Record button on and set for <u>Available</u>. Remember to turn it off when you don't need it!
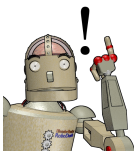
<u>**RoboDude Asks:**</u> **Why doesn't my armature animation start correctly on frame 1?**
When working with automatic key-framing, don't forget to move every bone a little at frame one to set the initial animation keys, then move up through time to make your next move. A lot of people forget to add keys to frame 1.

Creating Bone Vertex Groups

Using the *Automatic Weights* option works great for simple meshes and armatures, but when bones and mesh vertices are close together or far from the bone, Blender will have a difficult time deciding how to join them. In the example to the right, you can see that some vertices for one finger have been grouped with the bone beside it. We can alter these vertex groups.

RoboDude Says: Notice how you can see the bones through the mesh in solid view in the hand example?
There is an X-Ray option in the Object Data-Display panel that makes viewing armatures easier!

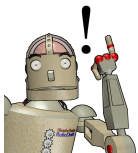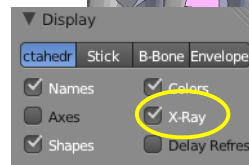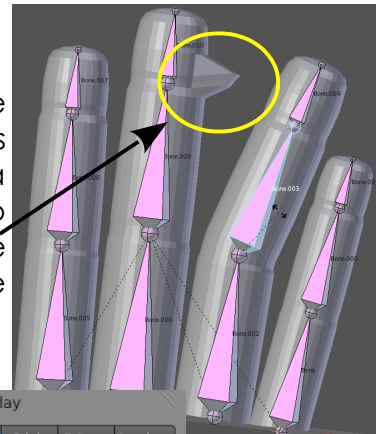With The bone <u>Names</u> turned on so you can see which ones you need to effect, select the mesh and enter <u>Edit</u> mode. Editing bone vertex groups is similar to making normal vertex groups except that Blender already named a vertex group to match every bone for you when you made the child-parent relationship. If you go to the Object Data panel (*mesh selected in edit mode*), you will see the list of groups in the <u>Vertex Groups</u> panel. You will also see the standard "<u>Assign</u>" and "<u>Remove</u>" buttons below the groups.

To fix the problem, you will first need to select the vertices you wish to change, then select the vertex group that they are wrongly assigned to. Hit the "<u>Remove</u>" button to remove them from that vertex group. In this case, they are wrongly assigned to "<u>Bone.004</u>". Now select the vertex group they need to be assigned to (<u>Bone.010</u>) and hit the "<u>Assign</u>" button. Exit edit mode, select the armature and move the bones in pose mode to test your groups.
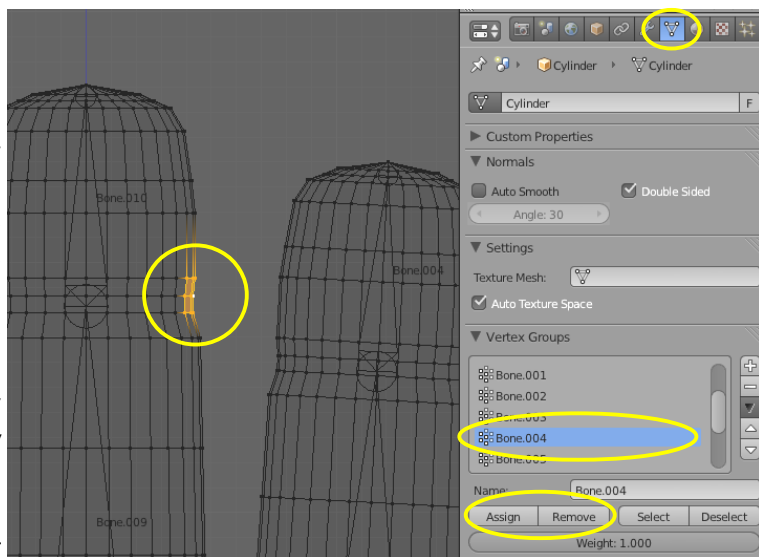
For vertices that are close to a joint, they can be shared between multiple groups. You can also use the "*Weight*" slider to adjust the bone influence for other effects, but normally, it is set to 1.000.

Need to take your posed armature back to it's starting pose? Change it from "<u>Pose Position</u>" to "<u>Rest Position</u>" in the *Object Data*.
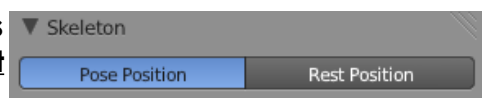
Using Inverse Kinematics (IK) and Constraints

Inverse Kinematics is used when you wish to manipulate a skeleton by simply grabbing (*G key*) the end bone of a chain and moving it with all of the connected bones following along. Inverse Kinematics is constantly under development and has a lot of options available depending on what you want them to do. *Visit www.blender.org for more details and review the wiki documentation.*
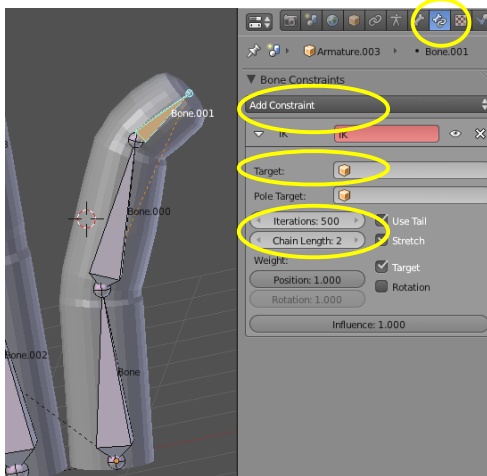
To use Inverse Kinematics, select the bone at the end of a chain, go to *Bone Constraints* and add an *Inverse Kinematics* constraint. You can control the number of bones in the chain (*Chain Length*) and even give it a *Target* to point to, like an empty. There are a few other options available including *Influence* (amount of effect). Once applied, you can use the "G" key to move the bone around while all those in the chain below it move in relationship to it.
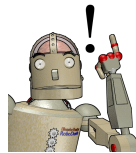
RoboDude Says: Press "Ctrl-A" to reset an object's rotation and scale. Works with individual bones in Pose mode. This help's a lot with these constraints!

Using Rotation Constraints:

When animating an object (like a finger), you may want to limit the direction and angle the object can bend or some "unnatural" things may occur when you try to add animation keys. Using *Limit Rotation* constraints can help with that. For the example to the right, I've applied a rotation constraint to the top 2 bones of the finger limiting the Y and Z axis to a limit of 0 degrees while the X axis can rotate from 0 to -60 degrees. This works because I switched the "*Convert*" from "*World Space*" to "*Local Space*".
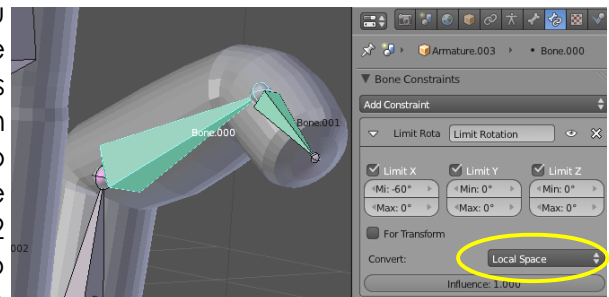
Copy Rotation:

Copy Rotation can make animating chains easier. In the example, I've created a *single bone armature (not a bone in the existing armature)* and *child-parented* it to the hand armature. This bone can be placed anywhere you wish. I have mine above the finger that it will control. Set it's rotation limits with the *Rotation* constraint discussed above, then add a "C*opy Rotation*" constraint to each bone that will copy it's movement. Select the control bone for the *Target*. In my case, I needed to *Invert* the motion to work correctly.
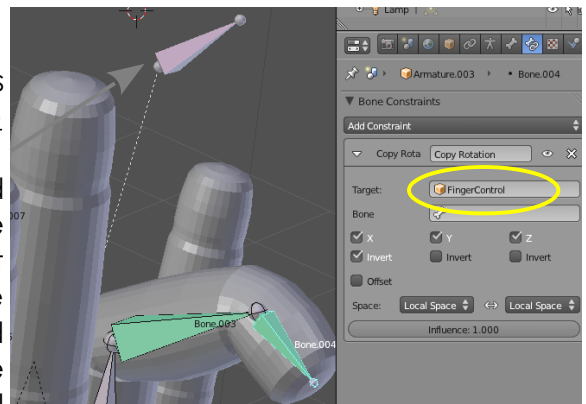
Create a Hand With Armatures

In this exercise, you will be creating a simple hand using meshes and armatures. Start a new Blender file and call it "*Hand*". As discussed at the beginning of this chapter, make a simple finger using a cylinder or filled circle. Extrude it to have 2 joints and looks something like this:
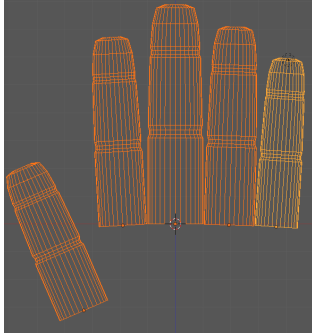
Now duplicate (*Shift-D*) the finger 4 times, scaling and rotating them into the shape of a hand. Don't worry if it doesn't look perfect- this is just a simple exercise. Try for something like the image to the left.

In order to add the palm of the hand, I used a UV Sphere and scaled it in the "Y" direction to make it narrow and used *Proportional Editing* to shape it to fit the fingers. Try shaping yours into something like this.
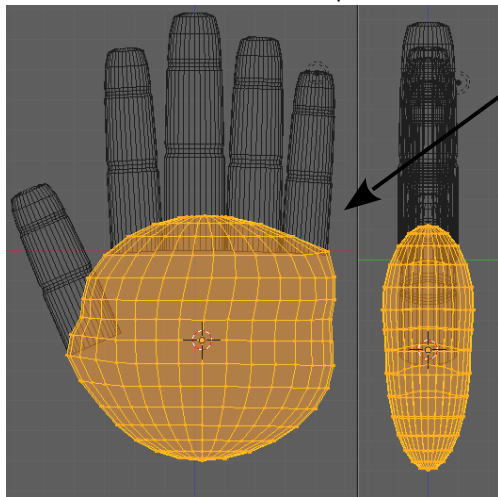
After shaping, select all of the meshes and *Join* them together (*Ctrl-J*).

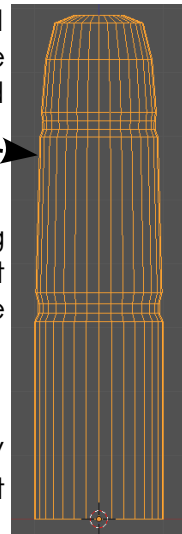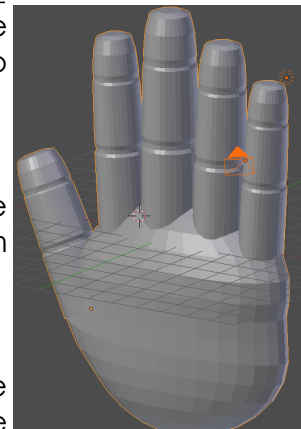It's now time to add the *Armature*. We will only be animating the fingers opening and closing for this exercise so we only need bones in the fingers. Place your *3D Cursor* at the base of one finger. As discussed in the chapter, add an *Armature*, then enter *Edit Mode* and pull the top end of the bone to align with a joint. *Extrude (E)* 2 more bones to fill the finger. Exit *Edit Mode* and return to *Object Mode*.
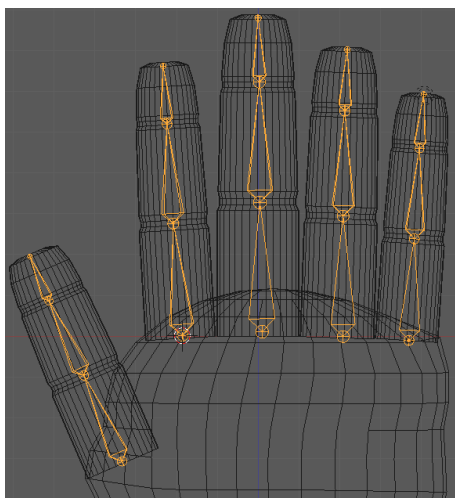
Now *Duplicate* the armature (*Shift-D*) and place it in the next finger. Enter *Edit Mode* and move the bone joints to match the mesh finger joints. Exit *Edit Mode* and continue duplicating and adjusting armatures until all fingers are finished. When finished, use *Ctrl-J* to joint all the armatures together.

It's now time to create the child-parent relationship for the mesh to the armature. Use "_Armature Deform_" and "_Automatic Weights_" as discussed in the chapter when using "*Ctrl-P*" to make the relationship. Remember to select the _Mesh_ first. It will also be helpful to turn on "_Names_" and "_X-Ray_" in the *Object Data* panel. Feel free to change the display type in that panel as well if you wish.

Enter Pose Mode and test your armature out to see if it works well or if you need to adjust vertex groups. If it needs adjustment, follow the steps of re-assigning vertices to the various bone groups discussed in the chapter.

When everything looks good, create a simple 200 frame movie of the hand moving.

Challenge Exercise:

Add constraints to limit rotation or control armatures with rotation copy constraints.
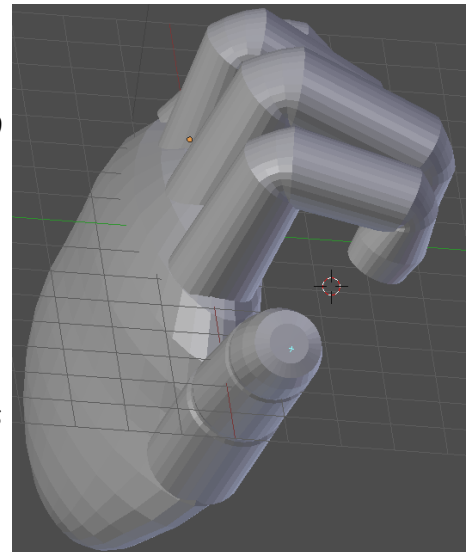
_ Call the instructor when finished**_**

Challenge Task- Flubber Character

In 1997, Robin Williams starred in a remake of the 1961 movie "*The Absent-Minded Professor*" called "*Flubber*". In the remake, Flubber is a green gelatinous material with a mind of it's own.
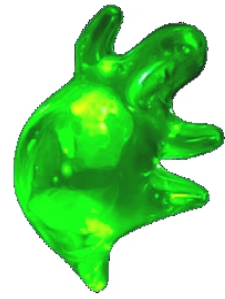
Search YouTube for some video clips of the Flubber character to get a sense of this project. Some possible video clips could be:

- **https://youtu.be/HJT2QOpnYb8**   Discovering "Flubber"
- **https://youtu.be/KyPqOt_Pgiw**   *MAMBO!" Of Walt Disney's FLUBBER Movie*

Note: These links were active at the time of publishing and have been active for years. You may need to search for other links.

For this challenge task, you will create a Flubber character with armatures and create a short 200 frame animation with appropriate background, objects, and lighting of your choice.

Back in Chapter 12 you were introduced to *Meta Shapes*. Meta Shapes are the perfect element to use to create the body of your Flubber character since they act like fluids and "pull" together. By applying appropriate materials with reflection, refraction, and transparency, you can achieve a very convincing Flubber. For a refresher on Meta Shapes, refer back to Chapter 12.

Creating the Character:

Start with a new Blender scene and create a Meta Ball from the **Add Object- Add Metaball- Ball** in the *Front* view. This will act as the belly of the Flubber character.
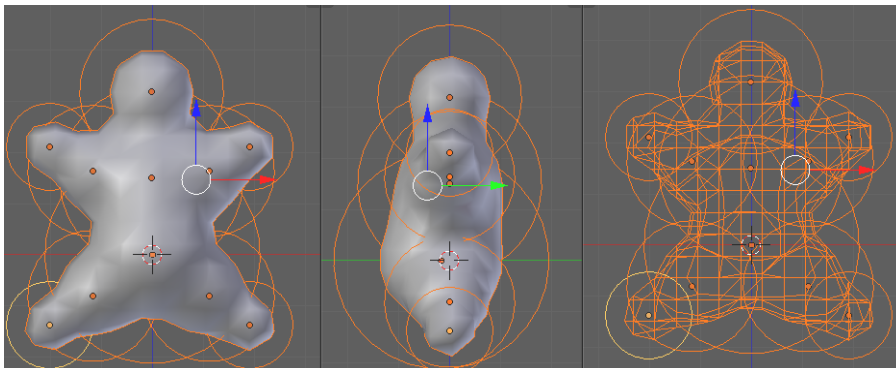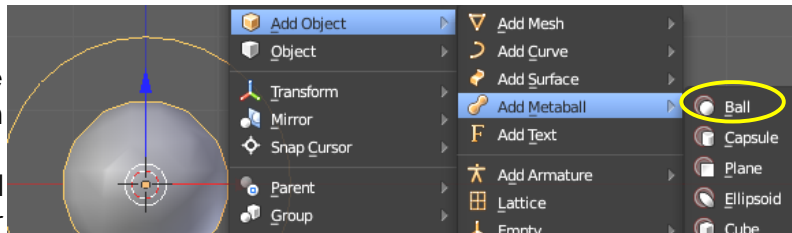
Duplicate the Meta ball and continue to shape a character of your choice. It may be best to keep the character simple, with only 10-15 Meta shapes.

Adding an Armature:

After you finish shaping the character, add an ***Armature- Single Bone*** to the character's belly. Continue to extrude and shape the skeleton of your character, using the information provided in the chapter, until you have something similar to the image below.
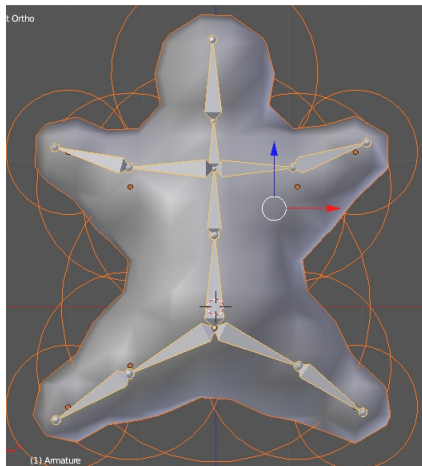
With the armature selected, enter ***Pose Mode***, select a Meta Shape, then the bone you wish to control it. Child-parent the Meta Shape to the bone using the ***Bone*** option.

Continue until all Meta Shapes are Child-parented to the bones. Test your rigging to make sure everything works.
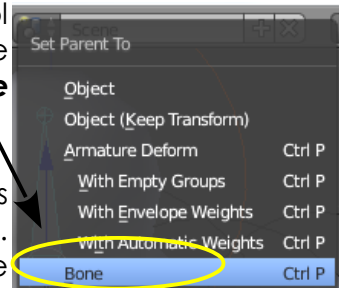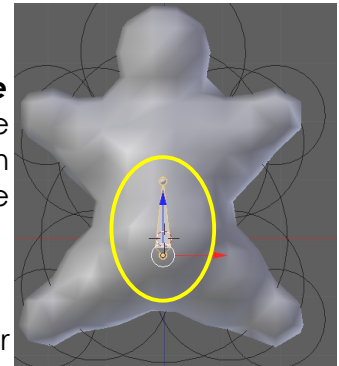
Create your scene and animations using the key frame techniques discussed earlier.
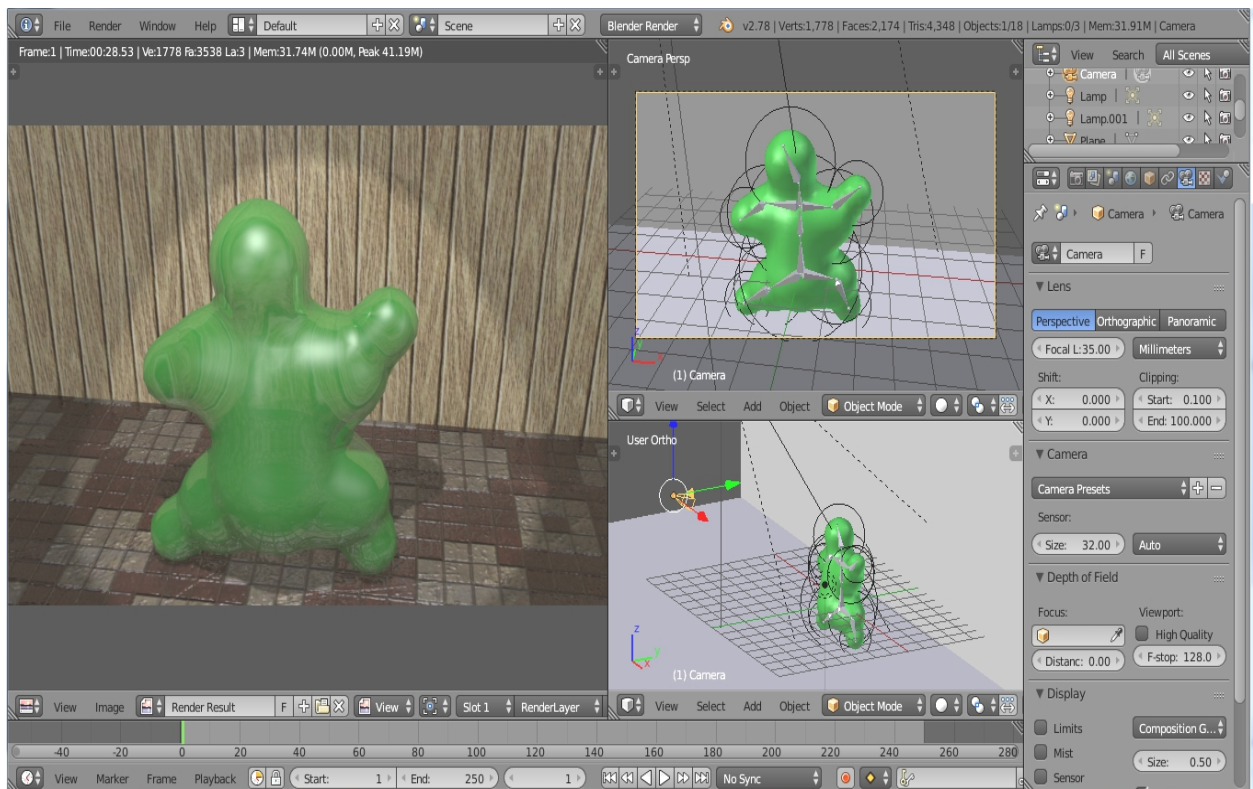
*** Call the instructor when finished**

Chapter 17 Reflection and Wrap-up:

Character Rigging

This chapter dealt with the basics of all character rigging. Every program is a bit different, but all operate the same. Take a few moments to reflect on what you learned.

1. **After completing these activities, what did you find to be the most difficult aspect of your work and why? Explain.**

2. **Internet research the job of a Character Rigger. What do they do and who do they work with? What does the job pay and how plentiful are these jobs? What did you learn from your research? Explain.**

3. **Depending on the detail in your character, rigging can be a difficult job trying to assign vertices and weights to everything. How should characters differ between characters designed for animation and characters designed for games? Research and explain your findings.**

Creating Mesh Shape Keys

We've discussed deforming a mesh with an armature, but what if you want to deform a mesh in other ways like have it flatten, move a mouth, blink an eye, etc. and have a way of repeating that motion whenever needed? Some of these things can be done with armatures, but sometimes it's easier to set up a **slider** that at one end, represents the mesh in one form, and at the other end of the slider, shows the mesh fully deformed. See the example below:
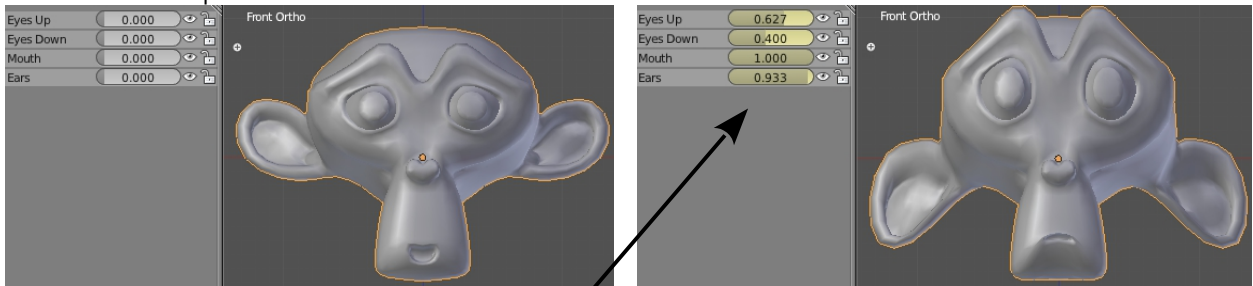
Mesh deformation using *Shape Key* sliders *(called vertex editing in older Blender)* in the <u>Dope Sheet Window</u> can be a difficult process because it requires you to shape your mesh in edit mode moving vertices. With practice, this can become a worthwhile tool that will enable you to make quick and high-quality animation like the professionals do. If you notice in the above example, there are several sliders that cause different motions. By using combinations of them, a wide variety of motions can be produced *(for example, Eyes Up/Down will combine the motions)*. These are great tools for making a character speak, blink and show expression.

In order to start using shape keys, we'll start a new scene, delete the initial cube, then add a *Monkey* head from the *Mesh* menu. To make the monkey head look better, we'll hit "<u>Smooth</u>" in the *Tool Shelf* and add a "<u>Subdivision Surface</u>" modifier from the *Modifier* panel. I have also rotated the monkey head to be facing forward in the *Front View* in *Ortho* mode. Now, find the "<u>Shape Keys</u>" panel in the *Object Data* buttons.

In order to start using shape keys, press the "**+**" in the *Shape Keys* panel to add a "<u>Basis</u>" group to add keys under. This "*Basis*" is not an actual key, but contains all the keys you now create under it. This can also be renamed.
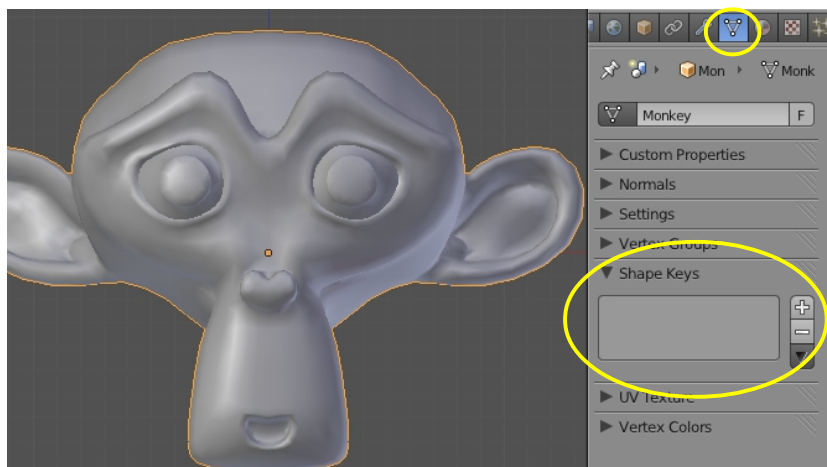
In order to add your 1st slider, press the "**+**" button again. You will have another key show up under the *Basis* called "<u>Key 1</u>". It's a good idea to rename these keys to something matching the motion that you plan to create. A good facial animation could contain dozens of slider!

Chapter 18- Relative Vertex (Shape) Keys
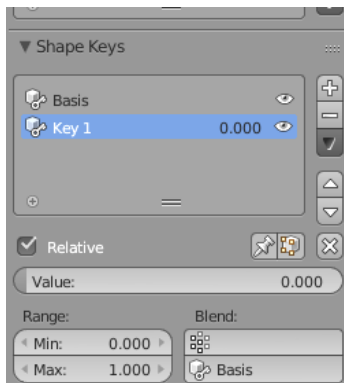
We will now create the motion for this "*Key 1*". You will notice a "relative" block checked by default, meaning that the motion we create is relative to this initial face shape. You can change the name of the key by double clicking it. Right now, it doesn't do anything because we haven't deformed the mesh. There are also range settings and group references we won't be working with now. I usually keep the value of the slider set to zero at this point.

It's now time to enter <u>*Edit Mode*</u> and alter the mesh for our first key. I want to make the monkey look surprised for this key by just raising his eyebrows. To do this, I will select a vertex above each eye (*total of 2 selected vertices*), turn on "<u>*Proportional Editing*</u>" and scroll the mouse wheel to change the selection circle while moving the vertices up. After you have the look you wish, go back to <u>*Object Mode*</u>. The mesh should return to 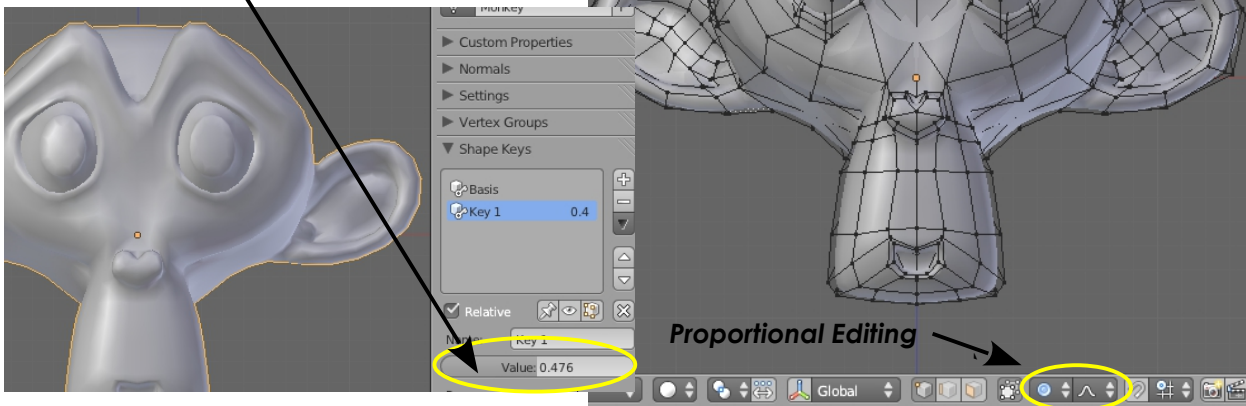it's original shape. Test the slider for the shape key. It should transition from normal to surprised as you move the slider.

Selected Verticies

Proportional Editing

T o add another slider, <u>*return the value of the previous slider back to zero*</u>, then press the "**+**" for the next key. *By lowering the slider, the next key will start with the basic mesh in edit mode, otherwise, it will be deformed.* Name the new key, enter Edit Mode repeat the process by shaping the mesh as desired, then returning to Object Mode to set the shape key. Test the slider.

Repeat this process to add any number of shape keys. It is important to return all sliders to zero before adding a new slider if you want to create from the untouched original mesh.
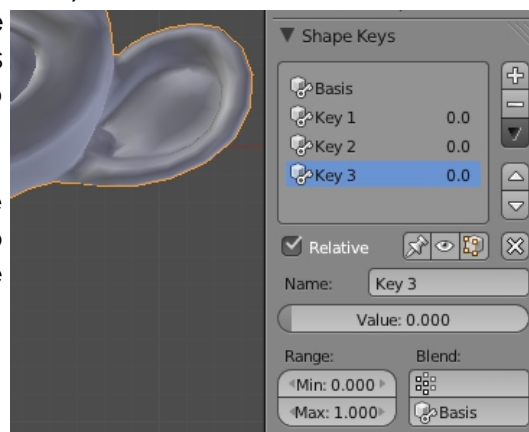
Using Action Editor Sliders

Now that you have created the sliders, it's now time to look at an easy way to animate them. If you review the animation chapter, you'll see a description on how to work in the <u>Dope Sheet</u> window. First th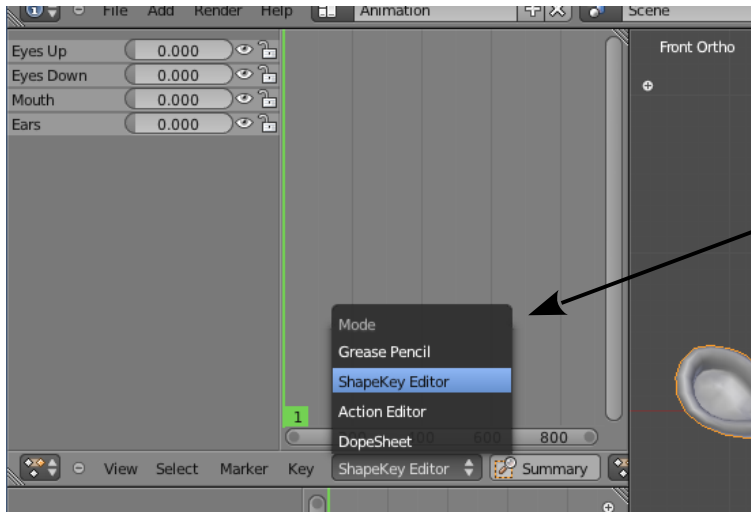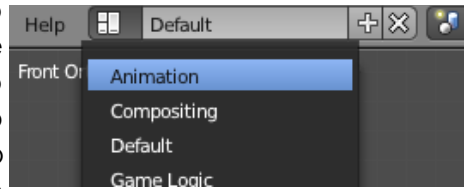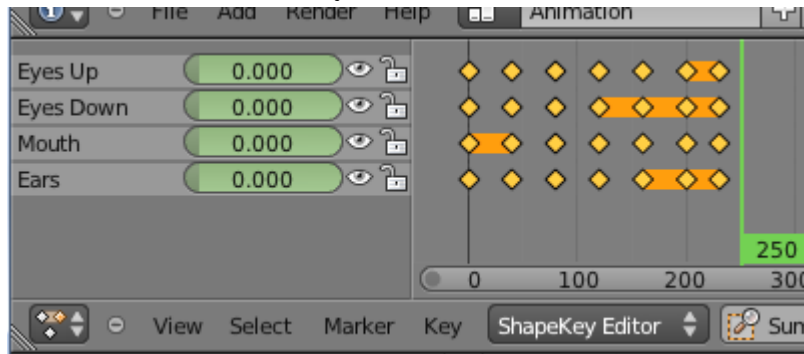ing we need to do is change our screen layout from "<u>Default</u>" to "<u>Animation</u>". Your screen configuration will change to show a *Dope Sheet* window, a *Graph Editor* window, *3D* window and *Buttons*. We're interested in the Dope Sheet Window. In order to see your shape keys, we need to switch the view from <u>Dope Sheet</u> to <u>ShapeKey Editor</u> at the bottom of the window. You will now be able to see all your shape key sliders in the window. You may need to adjust the size of the window so you can see everything.

Animation is as easy as moving a slider. As you move a slider, a small diamond will display on the time line to the right of the key. This diamond is an animation key at the current frame. After you set all sliders on the current frame, move up in time to your next desired frame and adjust the sliders. You are now animated over time. With a little practice, you will be able to animate easily using this technique. After you have placed some keys along the time line, go back to frame 1 and press "*Alt-A*" to see the animation (*or press the play button in the time line controls*).

As you animate, you can select keys (*selected keys are yellow*) and copy, move and scale them using standard Blender commands for other spots along the time line. A key that doesn't change over time is shown by a bar between keys. Keys can also be selected and deleted easily.
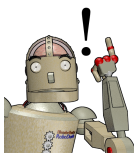
> **_RoboDude Asks: Why are shapes changing when I haven't inserted keys?_**
> *Remember that features change over time and begin changing from one key to the next. If a slider shouldn't change for, say, the first 50 frames, then change from frame 50-70, you will need to set a key at frame 50 and not just at frame 1.*

Chapter 18- Relative Vertex (Shape) Keys

Syncing Audio With a Shape Key:

Another neat way to animate a shape key is to use an audio file to sync with the motion. This is a quick way to create a lip sync or an object, like a speaker, bounce with the bass.
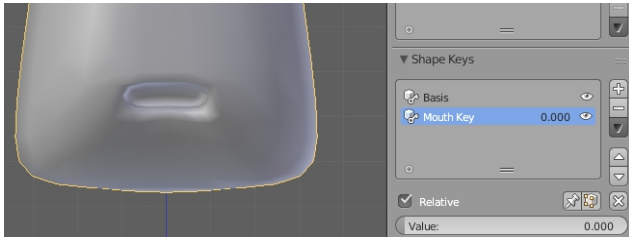
For this example, we are starting with the monkey head as before, but only applying one shape key for now on the mouth. The shape starts with a closed mouth and a key applied with a large "oh" shape on the key.

Initial Shape before applying the key.
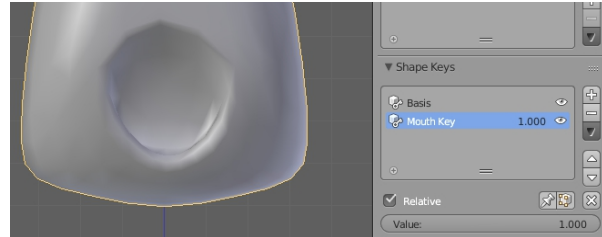
Shape with the value slider at maximum.

Now, switch over to the *Animation* screen layout and apply a key at frame 1 with the slider at zero and a key at frame 5 with the slider at 1.00. The number of frames between the 2 keys is not too important and 5 seems to work well. All you are doing is adding 2 keys at the minimum and maximum positions.
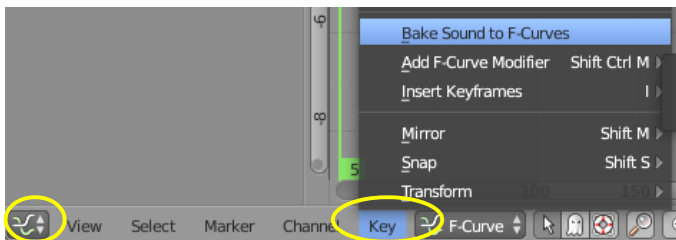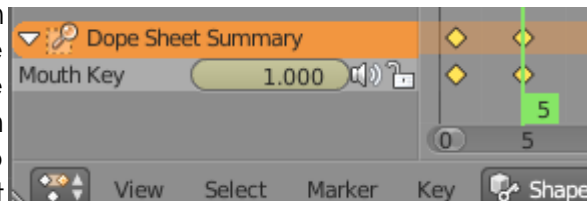
Now go down to the Graph Editor window. You should see the key graphed. Under the "*Key*" menu, select "*Bake Sound to F-Curves*". Browse out to find an audio file that you plan to use. The curve will reflect the sounds

spiking with the keys you created. If you hit the play button at the bottom of the screen, the monkey should be moving his mouth in sync with the audio file, but you will not hear any sound at this point.

To add the audio to the scene, you will need to switch to the *Video Editing* screen layout and add the audio file to the timeline. The Video Editor is discussed in Chapter 24.
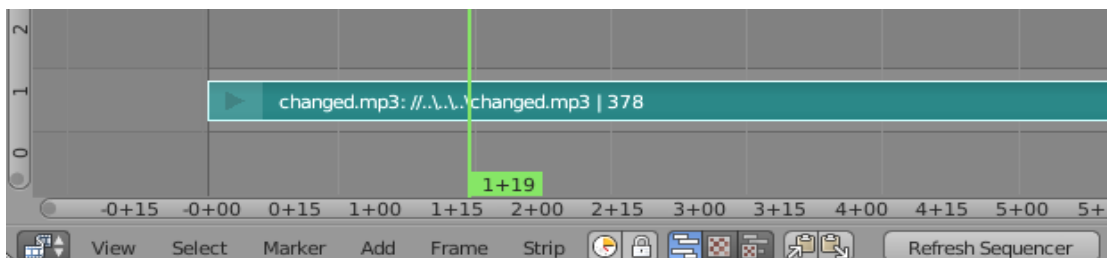
To test your mesh shape key and facial expression skills, we are going to animate the monkey talking and making expressions. Start a new file and call it "_Mesh Keys_". Add a _monkey head_, rotate it to face forward in the front view. Add a _Subdivision Surface_ modifier and press "_Smooth_" in the _Tool Shelf_. Create your _Shape Keys_ as discussed in the chapter, then switch to the _Animation_ view configuration.

Remember that you need to create the "_Basis_" group key first, then press "**+**" again to add the first slider. Enter _Edit Mode_ and turn on _Proportional Editing_ to make your first key. Try to go for a surprised look.

Continue adding mesh keys to bring the monkey to life using proportional editing. Add another slider to the eyes making him squint. Add a slider to move the ears. Add one to his mouth. In total, have at least 4 shape keys. Add more for more expression if desired.
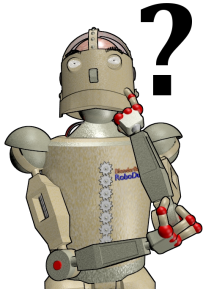
Challenge: If time allows, try adding an audio file to make him speak.

When you are finished, animate a short 200 frame movie making expressions.
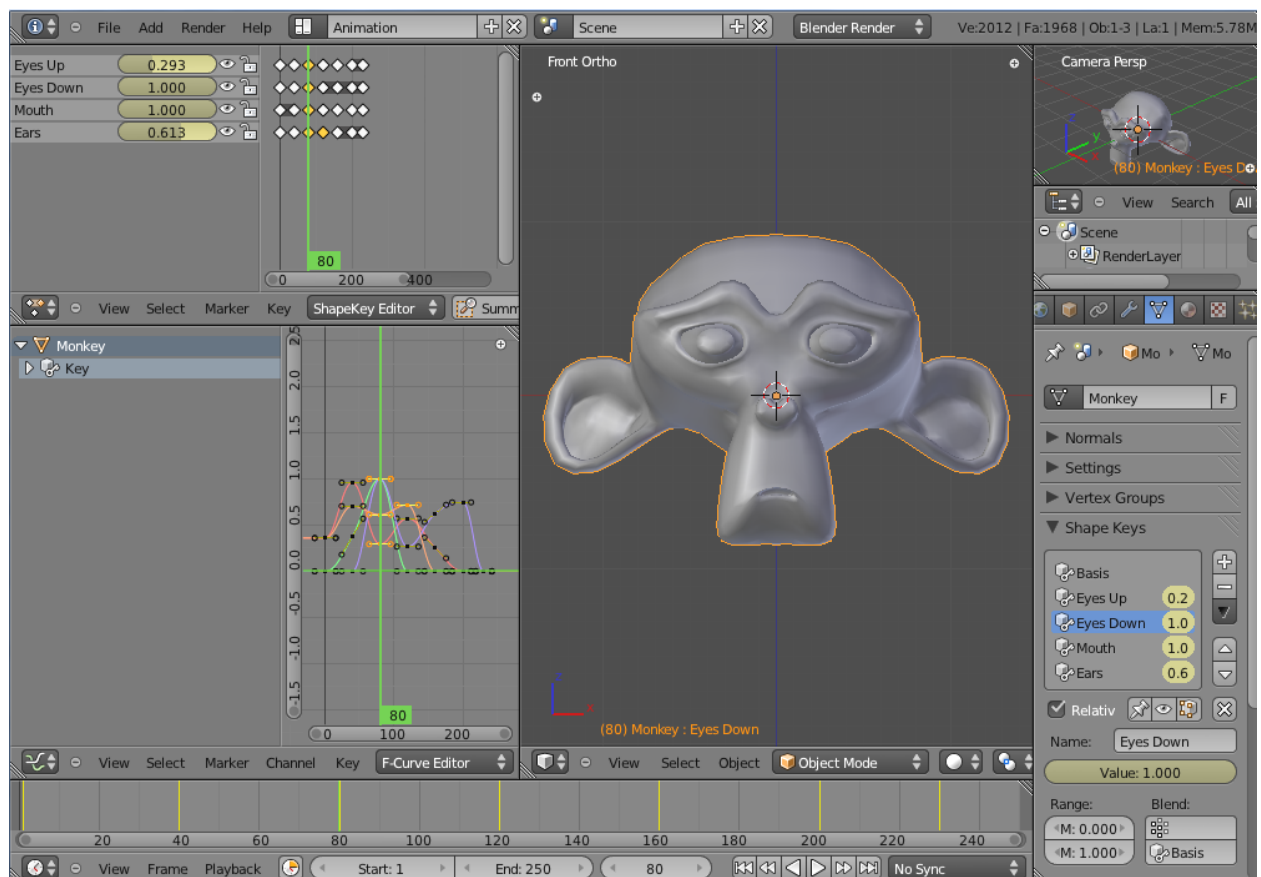
** Call the instructor when finished**

Chapter 18 Reflection and Wrap-up:

Shape Keys in Motion

Shape keys are used heavily in the movie industry. Take a few moments to reflect on these questions.

1. **As you worked through this chapter, what did you find to be the most interesting aspect of shape keys? What was the most challenging? Explain.**

2. **In the Eddie Murphy movie "Haunted Mansion", shape keys, identical to Blender, were used to animate the singing bust heads in the cemetery. Research the internet to find how this example, or a different example, of shape keys were used in a movie. How are they used? Explain your findings.**

3. **Music videos can make use of the "*Bake Sound to F-Curve*" feature, but most audio tracks are compressed down so all instruments and vocals cannot be separated (*i.e. drums only to effect an animation, or vocals for lip sync only*). What is a multi-track recording and how does the music industry use them? How could you use them for animations? Explain.**

Flowing water, fabric, things falling, and even a bouncing ball can be difficult to animate realistically using techniques we have already discussed. This is where Blender's **_Bullet_** physics engine becomes useful. Bullet is also used to create dynamics in the game engine, which will be discussed in a later chapter. Bullet has been used in Hollywood blockbuster movies to simulate buildings and debris falling and I expect to see it used more often, along with Blender, in the future. In this chapter, we will examine some of the basic features of Blender physics.

Here are some of the basic options in the physics panel:

Force Field: Force fields can be tied to any object and act like forces, wind, turbulence, and many other types of forces. Wind on an *Empty* is great for reactions to fabric and particles object physics effects.

Collision: Important for dynamic physics events. For example, if you want to control how particles interact with something like a floor (bounce, slide, or stick), you would place a collision effect on the floor. Also works with *Cloth* and *Soft Body* physics.

Cloth: As the name suggests, used to turn a mesh into a fabric. There are presets for various types of materials.

Dynamic Paint: Dynamic paint allows you to use meshes and particles as "brushes" to paint on other objects. The paint effect can be animated.

Soft Body: One of the oldest physics effects, *Soft Bodies* are used to simulate fabric, "jello", and water effects. Anything that requires a mesh to "flex" along it's mesh joint points and edges can benefit from Soft Body physics.

Fluid: Flowing water can be simulated in the physics panel. Set objects as a domain, inflow, outflow, obstacle, or fluid to create a realistic-looking fluid animation.

Smoke: As the name implies, set up a dynamic smoke simulation.

Rigid Body: This is where you can set up a dynamic interactive scene with objects falling, bouncing, and reacting with one another. Create a falling brick wall, bouncing ball, and domino chains. Build a Rube Goldberg invention or a better mousetrap.

Rigid Body Constraints: Create limit constraints on your rigid body objects, like hinges, pistons, springs, sliders, and rotational motors.
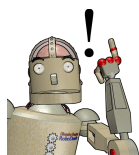
RoboDude Asks: *How do I remove a physics effect?*
You will notice that when you add a physics effect, an "X" will appear on the button. Just click the "X" to remove the effect. You will also notice that you can add multiple effects to an object.
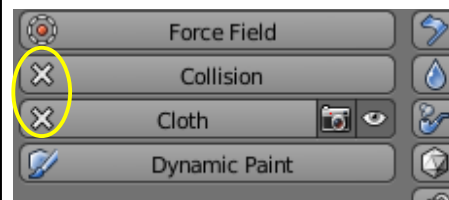
Creating Fabric and Fluid Effects with Interactions

Soft Bodies was one of Blender's first simulation features after Particles. Soft Bodies are used to simulate fabric, "jello", and water. While Soft Bodies still has a place in Blender for many effects, most people are just looking for a good fabric (cloth) simulation. Blender has pulled the fabric effects out of Soft Bodies and developed them into their own physics modifier.

Creating Cloth Effects

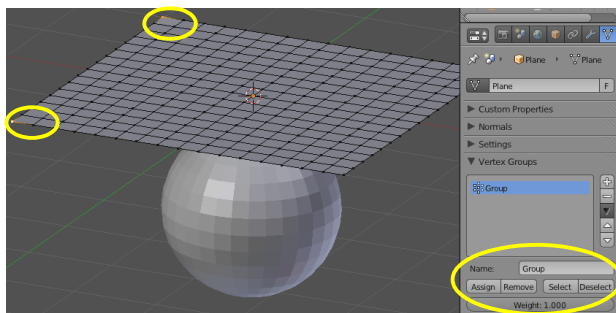We'll start with a simple scene of a plane placed above a UV Sphere. Scale the plane up about twice the original size and subdivide it 4 times. We will "pin" 2 corners of this plane and have it drop down over the sphere like a flag.

Our next step is to create a *Vertex Group* (*like we did in the Particles chapter*) in the *Object Data* panel. With all vertices selected, "*Assign*" a weight of *Zero*. Then, select only the 2 corner vertices and "*Assign*" a weight of *1.00* to them. These will be the 2 pinned corners we will use shortly. Return to *Object Mode*. Now select the *Sphere* and add "*Collision*" to it in the **Physics** panel.

In the **Physics** panel, add a *Cloth* effect to the *Plane*. Without any vertex groups, the cloth will fall and react with the sphere well (*has Collision on it*) when you press "*Alt-A*" or the *Play* button in the bottom timeline window. I've also used "*Smooth*" from the *Tool Shelf* for both objects.
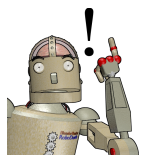
> ___RoboDude Asks: Why does the animation play so slowly?___
> *Calculating physics can be intense. Let it play through once to bake the data. It should play faster the next time through.*
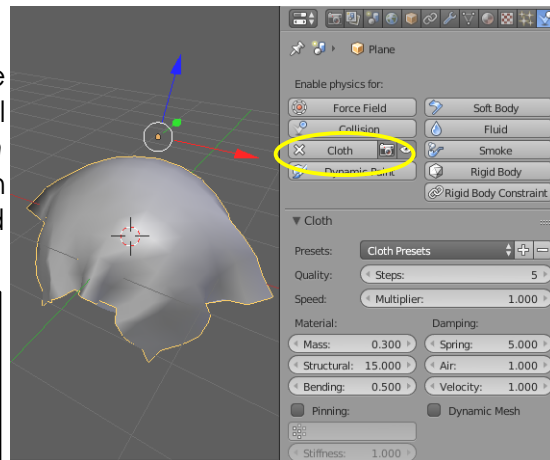
You can also use groups as before by checking the "*Pinning*" box and choosing the *vertex group*. You can also select various material types to simulate under "*Cloth Presets*". There are several other setting that can be adjusted for obtaining that perfect fabric.
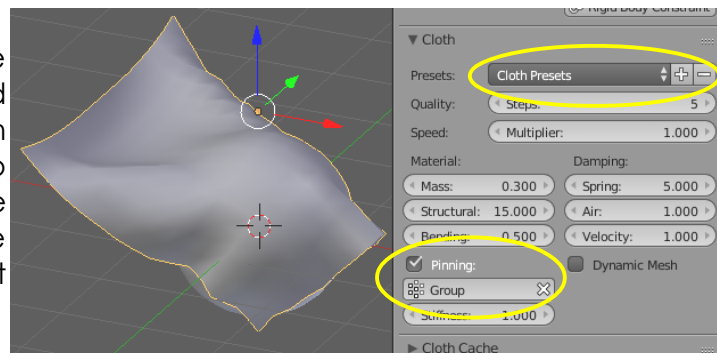
For this exercise, you can choose to either use _Soft Bodies_ or _Cloth_ physics to make a flag. Start by adding a *plane* and rotating it to face the *front view*. _Scale_ it to match an appropriate size for a flag and _Subdivide_ it a few times to give it enough vertices to flex well. Set the plane _Smooth_ in the *Tool Shelf*. Add a _Vertex Group_ in the *Object Data* panel as discussed in the chapter.
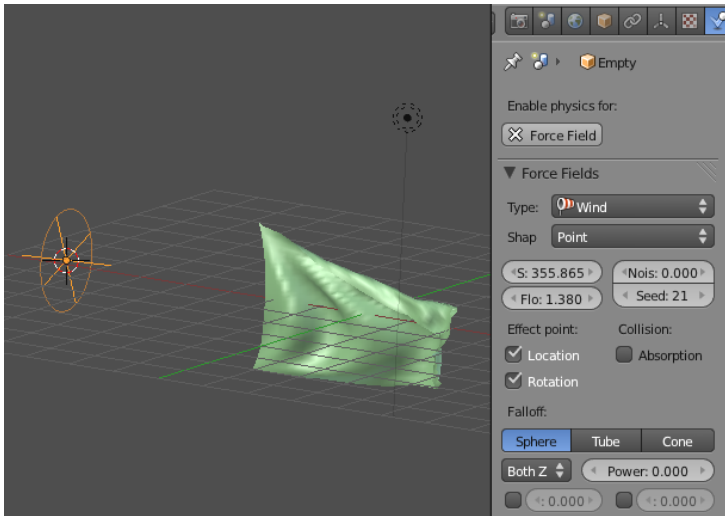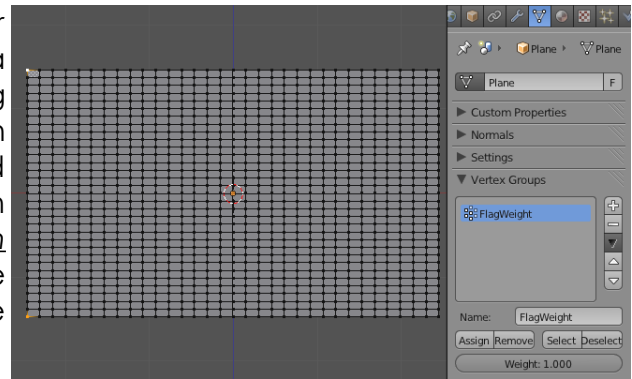
Apply physics to the plane as discussed before and adjust it to get a good effect. You may want to turn on "Self-Collision". Add an Empty to your scene and apply a "Wind Force Field" to it. Adjust the _Strength_ setting to get a good billowing flag effect. You may need a high strength number (hundreds) with a cloth simulation.

Add other details to your scene like a world background, a flagpole and anything else you wish. *Animate a short 200 frame movie when finished.*

** Call the instructor when finished**

Creating Fluid Effects

Blender fluids have received a lot of attention in in recent versions. You have the possibility of creating realistic fluid effects with these basic setting.
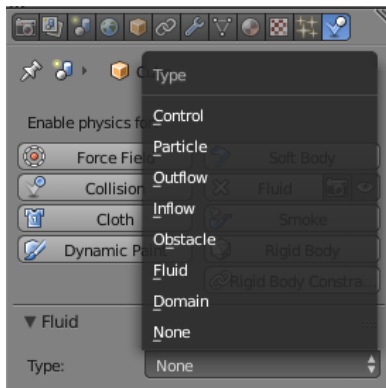
With an object selected and *Fluids* enabled in the *Physics* panel, you can set it as one of the following fluid object types (*by order of importance*):

Domain: Needed to contain all fluid physics. All fluid simulations must occur within the domain.
Fluid: An actual object that represents the volume of the fluid.
Obstacle: An object that the water can react with.
Inflow: An object that acts like water flowing into the scene (like a faucet. Used in place of the Fluid.
Outflow: An object that acts as a drain.
Particle: Allows fluids to works as particles. More work in this are coming in future releases.
*Control:* Adds additional control over fluid effects.

We will be discussing the basics in this chapter. For more details, see the Blender documentation at www.blender.org.

A Simple Splash:

Our fist example will just contain a *Domain* and a *Fluid*. The scene shown contains just a *Cube*, scaled up about twice it's original size, as the *Domain* and a *Sphere* that will represent the *Fluid*. The larger the sphere, the more fluid the scene will contain. It is important the the sphere is completely inside the cube.

With the *sphere* selected, make it be the *Fluid* in the simulation. You will see a few options including the ability to give it an initial velocity, rather than just dropping due to gravity. -Z will flow down.
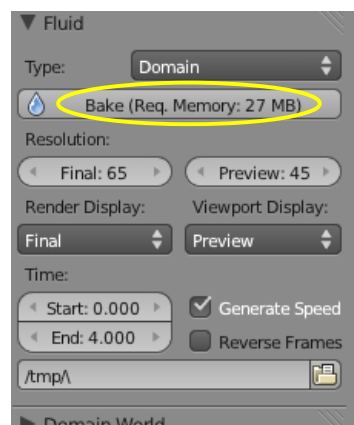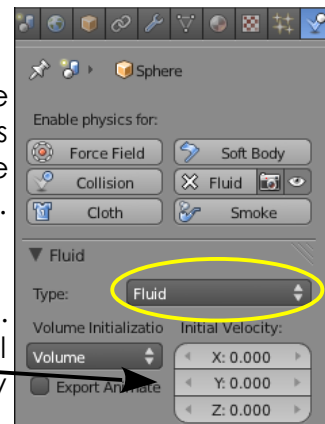
Now select the *cube* and make it the *Domain*. Remember that the domain contains the simulation and controls the baking of the simulation. Don't be concerned if the cube turns into a small blob due to previously cached baking. This will correct itself when you hit Bake. You can control render quality and time length in the domain. You can even specify a specific folder to save the baking into so it can be referenced later. Also, after baking, the cube is now represented by the starting fluid. *When everything is set, hit the "Bake" button and wait.* You can watch the status of your baking in the top program bar or hit "X" to cancel it.
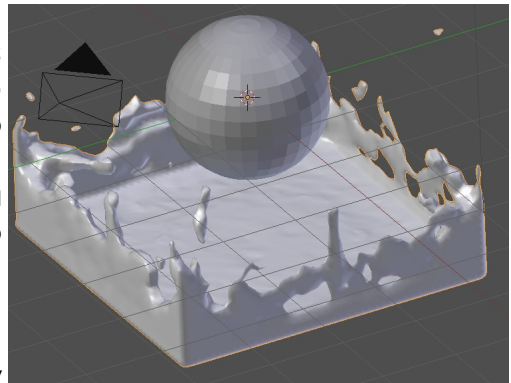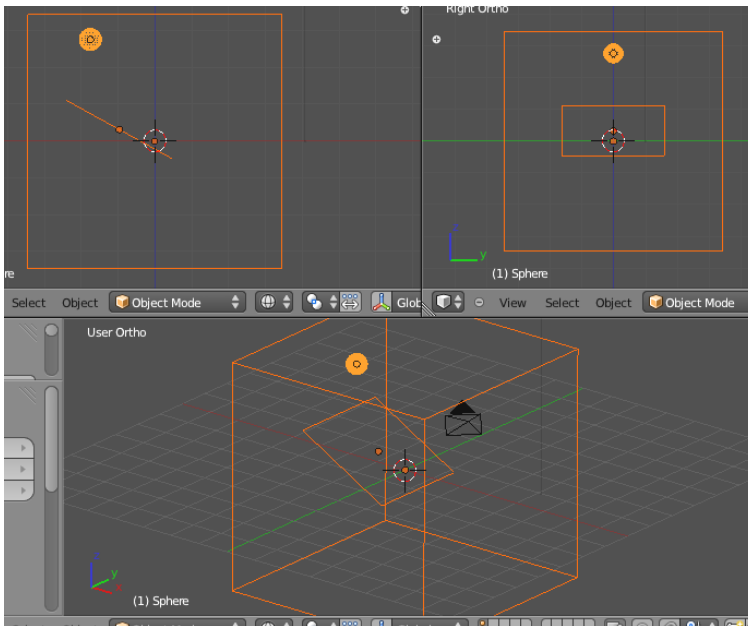
During the Bake, you will see a status bar at the top of the screen. You may also need to delete files from the */tmp* folder where the bake is saved to get it to work properly. When finished, hit "*Alt-A*" to see your animation. To improve the appearance, hit "*Smooth*" in the *Tool Shelf* and apply a "*Subdivision Surface*" modifier. You can also experiment with the time setting in the Domain.

This time, we will create a scene that uses an *Obstacle* and an *Inflow* instead of a *Fluid*. Start by creating a Blender scene similar to the below. The cube has been scaled up about 3 times it's original size and used as the *Domain*, an angled plane to act as an *Obstacle*, and a small sphere that will act as the *Inflow*. In the Physics panel, the 3 objects have been set up to reflect these items with special attention to the following:

Sphere- Inflow Object:
Give it an *Inflow Velocity* to make it flow into the scene. I used a Z of -1.000.
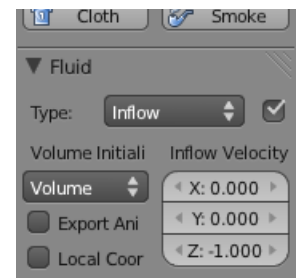
Plane: Obstacle Object:
Experiment with the *Slip Type* for a desired effect. This adjust how much fluid slips on the object. I chose *No Slip*. Select the *Domain Cube* and *Bake* your animation. Remember to watch the status bar at the top of the screen. It may take a while to bake.
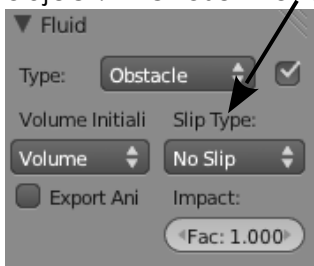
Animating fluids can be time consuming, but with practice and experimenting, you can achieve some nice result.
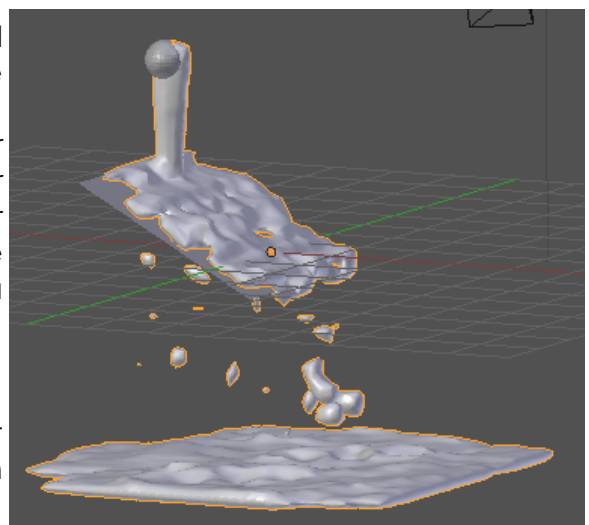
Chapter 19- Object Physics

Creating Volume Smoke

Volume smoke physics has seen improvements over the past few versions. With that being said, it is still worth an introductory discussion in this edition. You can find some nice tutorials and sample videos on the internet and the feature will probably be updated before anyone gets to this chapter of the book, but here it is:

Volumetric smoke works similar to fluids where you create a _Domain_ and an _Emitter_ (_Flow_). In order to generate the smoke particles, you also need to add a _Particle_ system and add materials and textures.

To start, we'll set up a new scene with a cube scaled to about 5 times the original size. Remember, all smoke that is created will not extend beyond the cube domain so it needs to be large enough for your scene. _It has also been recommended that you do not go into Edit mode and alter the vertices of the cube because of calculation issues._ Next add a Plane and place it to the bottom of the cube as the _Flow_. _Make sure it is completely inside the cube!_ Any mesh will work for the flow, but we'll work with a plane for now.
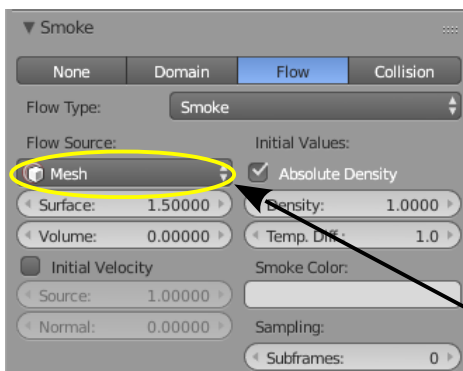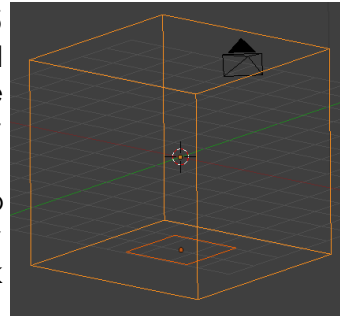
The smoke simulation can now either use the mesh (plane) to generate the smoke or particles. We will use the simpler default of the mesh, but particles could be used for more flexibility.

Time to work on the smoke physics. With the _plane_ still selected, add _Smoke Physics_ to it in the _Physics_ panel and select "_Flow_". You will see blocks for _Flow Source_. Make sure it is set to _Mesh_.

Now select the _cube_ and enable _Smoke Physics_ for it. Choose "_Domain_" for it's property option. We're now ready to take a look at our results by pressing "_Alt-A_" or the play button at the bottom of the screen. It will probably run through slowly, but you should see building smoke in the viewport window. If you try to render a picture at this point, all you will see is the cube and not the smoke. We'll fix that next.
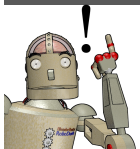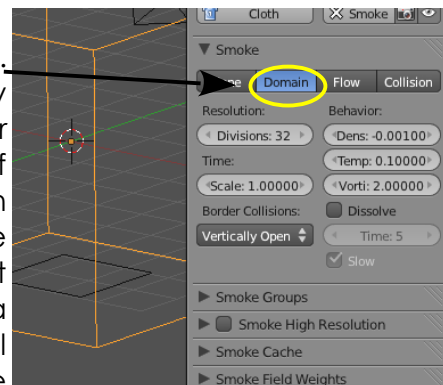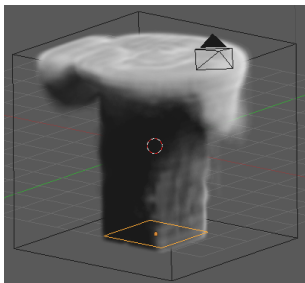
> _RoboDude Asks: What can I do with smoke?_
> _As long as everything stays within the domain, you can move the flow object and even add a wind force!_

In order to get a nice render, we need to do some *Material* and *Texture* work on the *Cube (Internal Renderer)*. With the cube selected, add a *Material*, set it to *Volume* (*we're filling the cube- not putting the material on the surface*), and set the *Density* to 0.000.
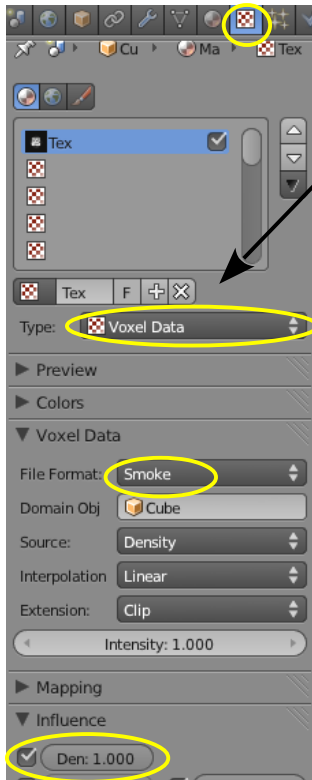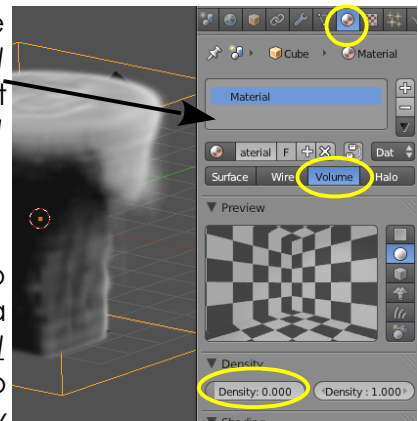
With the cube still selected, go to the *Texture* panel and add a texture. Change the *Type* to "*Voxel Data*", the *Domain Object* to "*Cube*" (*this object*), and *Density* under Influence checked and left at 1.000.

In order to animate your smoke scene, you need to *Bake* the data. With the cube still selected, go back to the physics panel and look at the settings in the *Smoke Cache* panel. You can set the frame start and end for the length. Finally, hit "*Bake*" and let it run. When finished, you can create an animation using the same techniques we have in past chapters. *If this panel is grayed out, it is because you haven't saved this file yet! Save the Blender file, then these setting should now be available.*
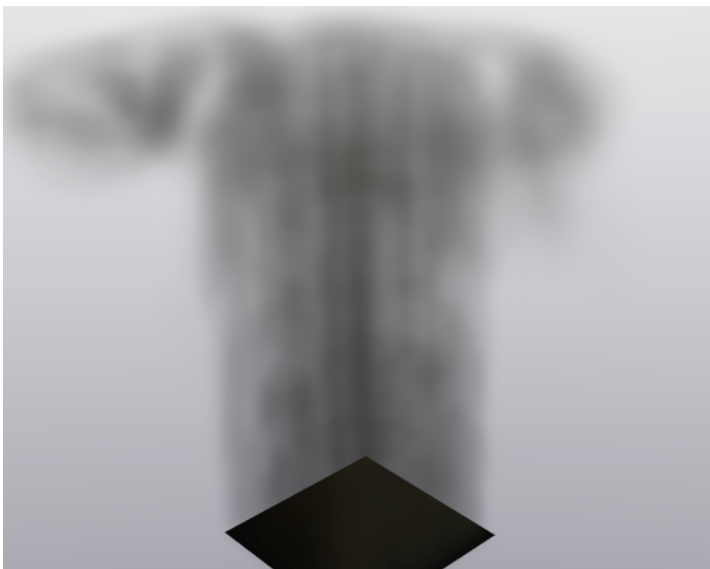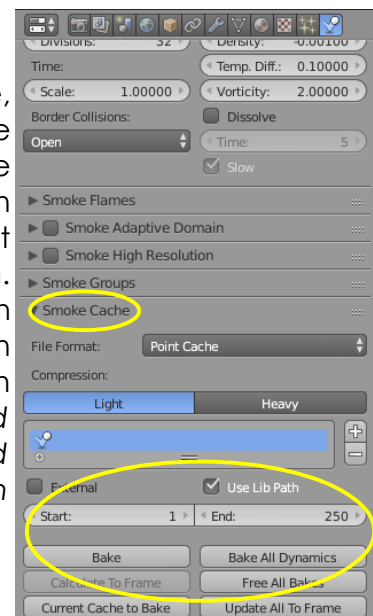
As with all other features we've covered, there are many other possible setting that can be experimented with. For example, particle settings can be adjusted in order to change density. You can also adjust the quality of the smoke resolution and field weights. Need a fire ball effect? Try child-parenting a sphere to your fire ball and use a smoke system for a nicer effect. Remember, just like water, all work must occur inside the domain.

Dynamic Paint Basics

Dynamic Paint is relatively new to Blender providing some interesting effects. It can be used to paint an object in animations using other objects or particles as brushes. For this example, we will create a simple scene with a *Plane* and a *UV Sphere*. The UV Sphere has been animated across the plane. <u>Subdivide</u> the *Plane* 4-5 times so we have some detail to paint.
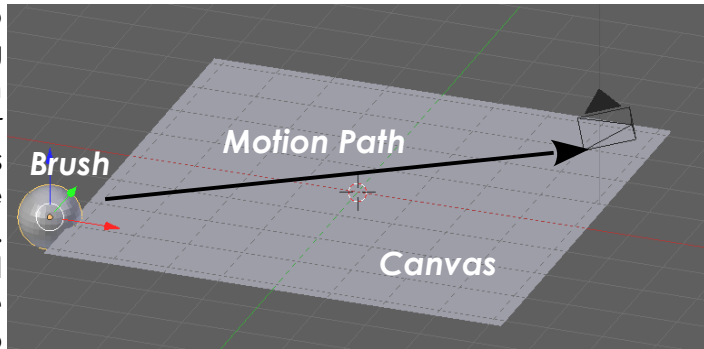
In the **Physics** panel under <u>Dynamic Paint</u> with the *Plane* selected, choose <u>Canvas-Add Canvas</u>. For the *Sphere*, add a <u>Dynamic Paint Brush-Add Brush</u>.
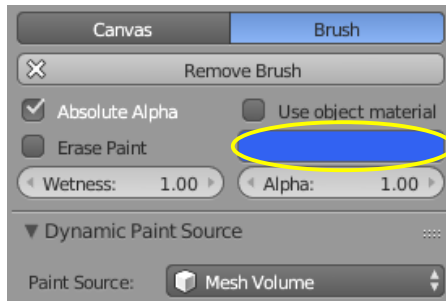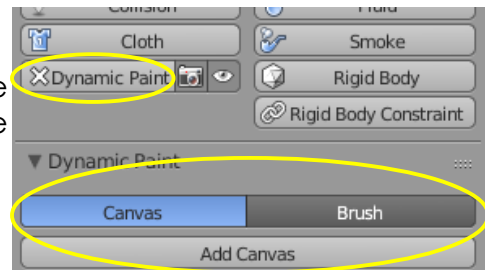
Make sure you are painting with a Blue color under the Sphere's brush settings.

By Pressing "Alt-A' or the play button in the bottom time line, you should be able to see a line painted across the plane.

You won't be able to see the effect in a rendered view yet and it would be beneficial to *Bake* the animation. Save the file, then select the <u>Plane</u>. In the <u>Dynamic Paint Cache</u> panel, select <u>Bake</u>.
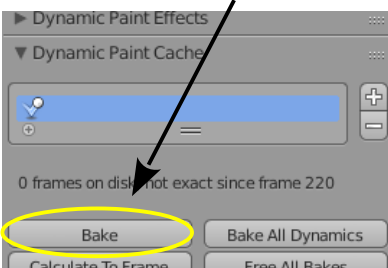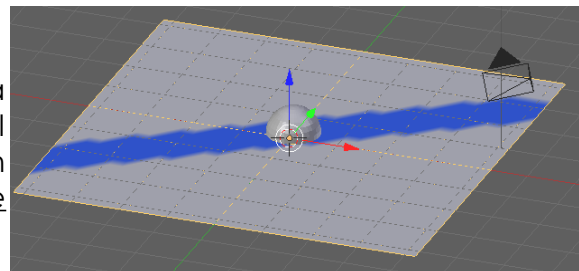
In order to see the effect in a rendered view, go to the <u>Dynamic Paint Output</u> panel and press the "**+**" by the <u>Paintmap</u> and <u>Wetmap</u> layers.
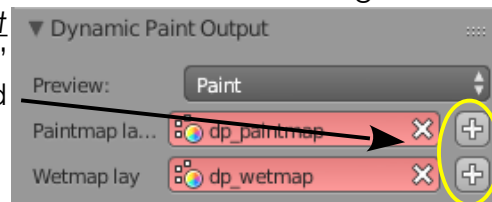
Finally, add a <u>Material</u> to the plane, go down to the <u>Options</u> panel and turn on <u>Vertex Color Paint</u>. You should now see an animated, rendered view of the paint effect.
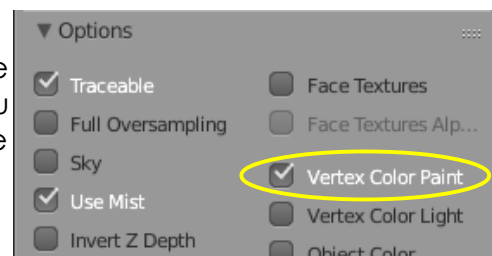
Let's make a new Blender file and call it "***Splash***". Start by deleting the initial cube in the _top view_ and adding a _Circle_. Set the circle settings to _15 vertices_ and click the "_Fill Type_" - "_Triangle Fan_". We will be making a small cup using this circle and keeping the mesh simple will help with the fluid physics.
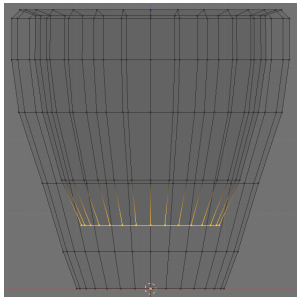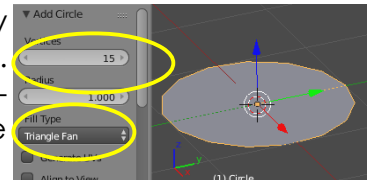
Switch to a _front view_ and begin extruding and scaling the circle to shape a simple cup. When you reach the top, scale the vertices inward and shape the interior of the cup. Again, keep the cup simple so our fluids simulation remains relatively manageable. After you model the cup, go to the _Modifiers panel_ and add a _Subdivision Surface_ modifier, also hit "_Smooth_" in the Tool Shelf.
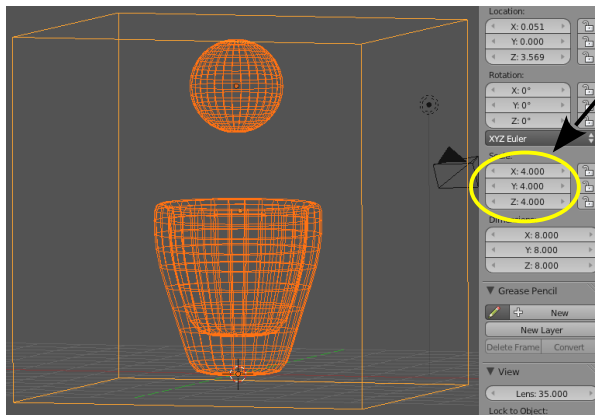
Now it's time to add a _cube_ and scale it to _4.00 units_ using the "**N**" key. Center the cube up around the cup. After adding the cube, add another _UV Sphere_ and place it above the cup, _but still within the cube_. Remember, all animation must remain within the domain (cube). Check all views to make sure the sphere is contained in the cube and over the cup.

Before we animate, go to the _Render_ panel and change the _End Frames_ of the animation from **250** to **70**. Now, go to the _Physics_ panel and enable _Fluids_. Set the _Cup_ as an **Obstacle**, the _Sphere_ as the **Fluid**, and the _Cube_ as the **Domain**. With the cube selected, press the "***Bake***" button and wait for the animation to calculate. After calculations, press "Alt-A" to check the animation. If it doesn't work well, hit "Ctrl-Z" to get back to the point where you see the cube again and experiment with some of your settings. If everything worked well, add some nice materials to your objects. Place the sphere into an unused layer (M key) and _Subdivision Surface_ the water.
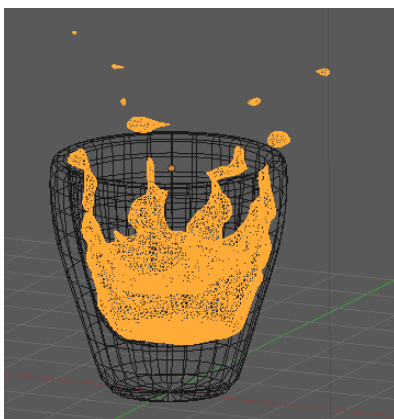
** Call the instructor when finished**

Realistic Object Interactions in Real-Time and Animations

At one time, all physics interactions had to be accessed from the game engine in Blender. If you wanted to use the physics interactions in an animation, you had to run the game engine while you recorded the motion, then go back to the render engine and finish all work with the animation. You can still do that, but many of the interaction physics have now been activated in the render engine for easier work. While we will discuss the basics of object interactions here, we will still discuss the options in the game engine chapter.

Rigid Body Objects:

For our example, I have set up a simple scene with a Plane, Cube, and Sphere. The *Plane* will represent a passive, static ground with the *Cube* and *Sphere* set above the Plane and both set as active, rigid body actors that will fall down and interact with each other and the plane. Add a Rigid Body physics modifier to each object.

For each Rigid Body *Type*, select "*Active*" for the Cube and Sphere (make sure the "*Dynamic*" option is checked) and "*Passive*" for the Plane. If you do not make the plane *Passive*, the objects will fall through the plane, ignoring it completely. Press the play button at the bottom of the screen to test your physics. All objects should react.

In order to adjust your reactions, you will notice some settings in the *Rigid Body Collisions* panel.

Mass: The mass of objects affect how they react with one another, like real life.

Shape: This determine the bounds of the object. *Convex Hull* and *Mesh* will give you the most accurate results, but may slow animations.

Friction: How much things slide against one another.

Collision Margin: Add a boundary around an object to help prevent objects passing through each other.

Bounciness: Adds an elasticity to objects, like a bouncing ball. Bounciness must be set on both interacting objects to work (*ball and plane*).
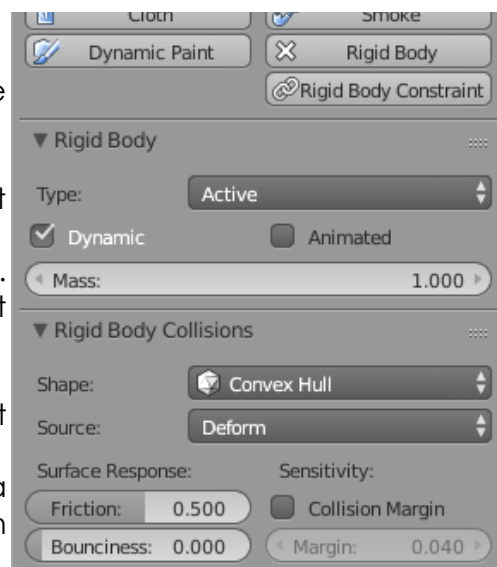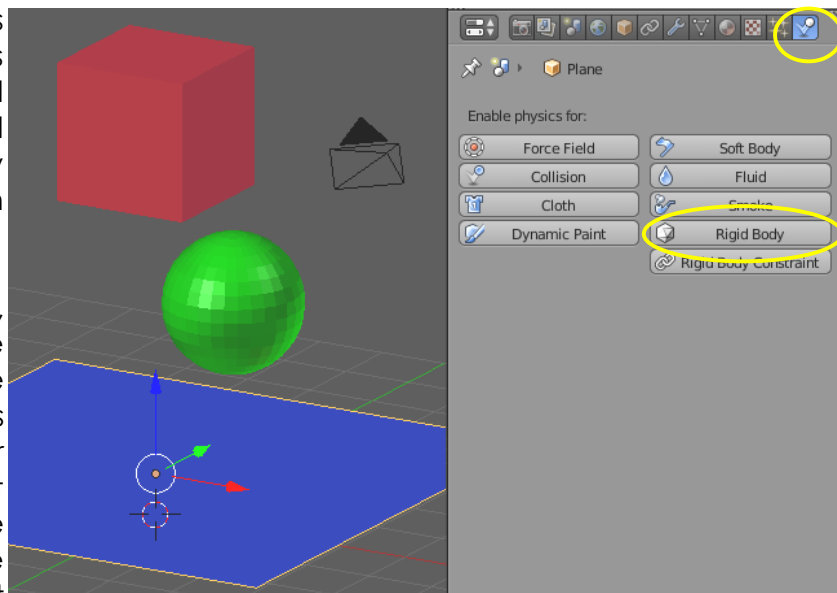
Rube Goldberg was an engineer and cartoonist that was best known for his imaginative drawings of elaborate machines that were designed to do simple tasks.
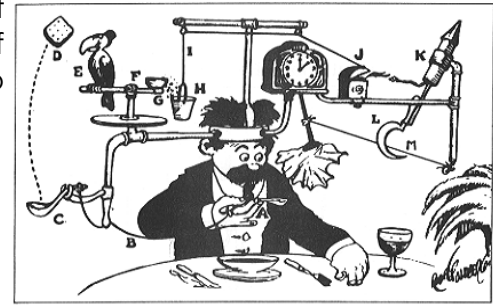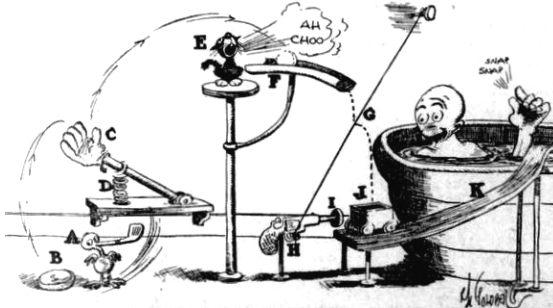
For this activity, you will create your own action/reaction system using Blender rigid body actors. Create a new Blender file called "**Rube Goldberg Physics**".

Research YouTube for "Blender Physics" or "Bender Rube Goldberg" for examples of what can be done. Your project should consist of at least one ball, one "domino" effect, one ramp effect, and some kind of tower. After creating your scene, add appropriate materials, textures, lighting, and camera motion. Remember to experiment with the collision settings of mass, friction,, bounciness,and shape. **Create a 250 frame movie of your project when finished.**

Note: If you want to create more than 250 frame, you will need to go to the <u>Scene</u> *property buttons and increase the* <u>Rigid Body Cache</u> *end frame.*
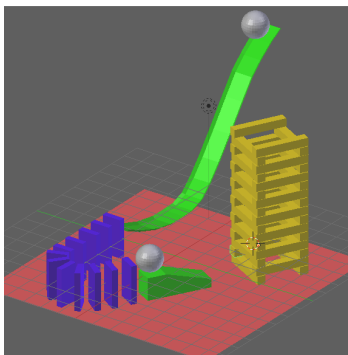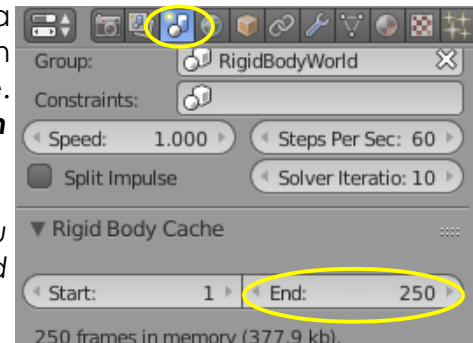
Challenge Task:

Try using animated objects that interact in your scene or <u>Rigid Body Constraints</u> to make a lever!

To create a lever from a cube, scale x,y,z, keeping the pivot point in the center of the lever. Make a cube stand for the lever to rest upon. Set the stand as a <u>Passive</u> rigid body and the lever as an <u>Active</u> rigid body. Add a <u>Hinge</u> Rigid Body Constraint to the lever. You will need to link the lever to the stand. Note the names of your meshes. For "**Object 1**", select the <u>Stand</u> mesh. For "**Object 2**", select the <u>Lever</u> mesh. Test your system and adjust as needed.

** Call the instructor when finished**
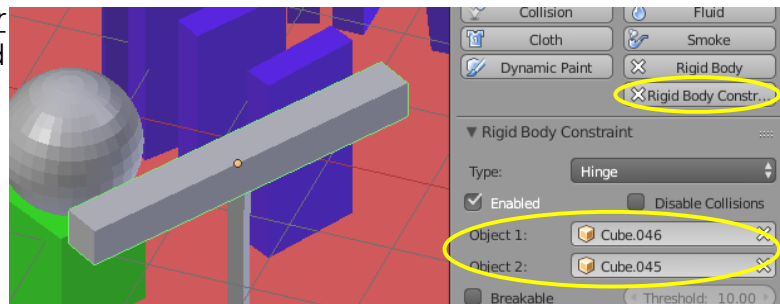
Chapter 19 Reflection and Wrap-up:

The Bullet Physics Engine

You have had some basics experiences in using the powerful Bullet physic engine in Blender to do some simple tasks. Take a few moments to reflect on your experiences.

1. **We used the cloth physics to create a simple flowing flag. How else could you possibly use this effect in an animation? Explain your answer and how you would set up the effect.**

2. **How did your fluid simulation model turn out? Working with fluid obstacles can be difficult, requiring some fine-tuning in the settings. Research the internet to find some examples of how other people have had success with fluids. What did you find out? Explain.**

3. **Movies like *2012* used the Bullet engine to make realistic objects falling in the scenes. Not only are objects set to rigid bodies, but particles effects are added to simulate dust, smoke, etc. Look for movie physics effect on YouTube. Pay close attention to special effects. What have you learned so far that could help you create some of these scenes? Explain.**

4. **Research the internet for examples where Blender physics have been used. What future projects do you think you would like to try to create using physics?**

So far, we see that Blender has many features that are found in almost all 3D computer programs like the ability to extrude along paths, subtract and add meshes through Boolean expressions and now we will examine **revolving-type, or spinning** commands. The commands used for these effects are found in the _Tool Shelf_ and are visible when in _Edit Mode_. The Spin and Screw commands can be used to revolve around a center point with duplicate objects or smooth spinning. You can also provide an offset that will create a spiral. The process to get them to work can be confusing to beginners so we'll create some basic shapes.
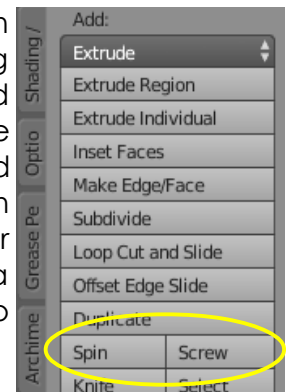
Creating Screws and Gears

There are actually mesh add-on tools that can create both of these items easily that will be discussed later in the chapter, but for now, we will look at the traditional way to create these items.

Screws and Springs:

In order to make these items, you need a closed shape for the profile (ex. circle or triangle) and a 2-vertex line that controls the spacing from one coil to the next. We'll make a screw form for our first example. Start by adding a _Plane_. In _Edit_ mode, select the 2 right side vertices and scale them down to make a triangle form that will represent the triangle thread. Move the 3D cursor to the left side and place it where you want the center of the screw to be.
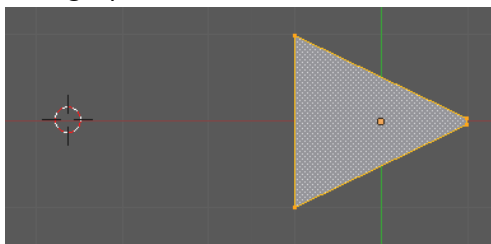
Now add another plane (_while still in edit mode_), delete the 2 right side vertices so that all you have is a line, and place those 2 vertices on the 3D cursor. These 2 vertices control the distance between the coils and must be part of the 1st mesh. If they are not joined together, use "_Ctrl-J_" to join them. My example has the line the same size as the edge of the triangle. This means that the threads created will be tight together. If you want space between the threads, make the line longer. I place these 2 point on the 3D cursor so it is easier to delete them later. Stay in _Edit_ mode.
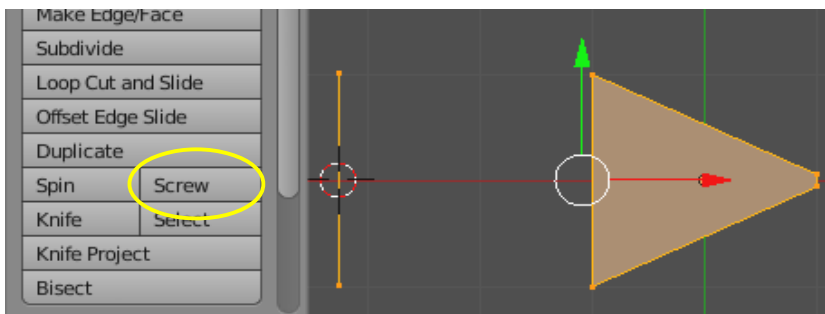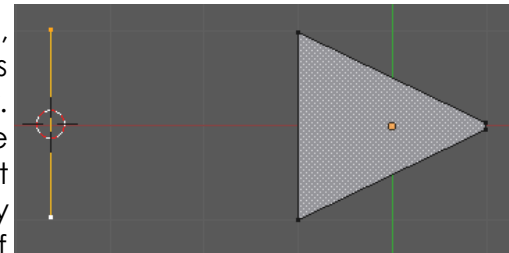
Now, use the "A" key to select _All_ vertices. The line and triangle vertices should all be selected. _Make sure you are in a principle view since the spinning will occur related to your view._ Select the _Screw_ command.
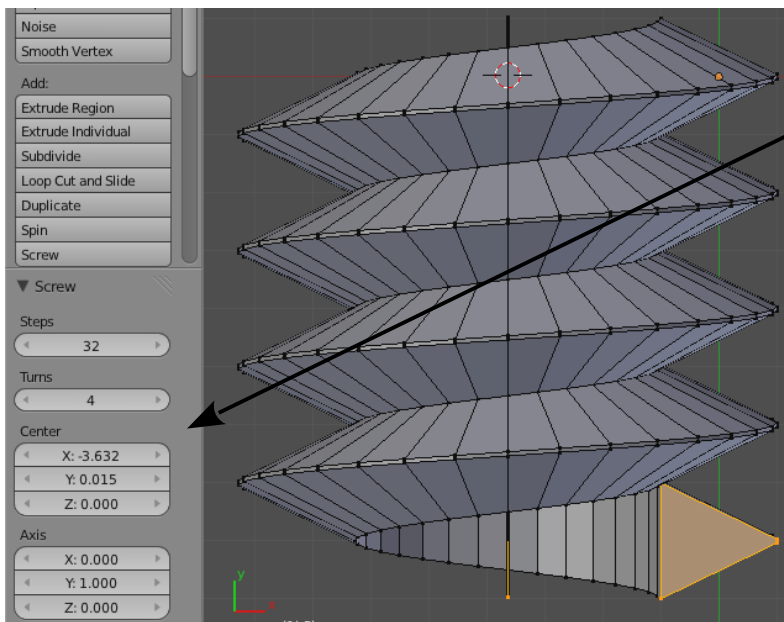
When you select the *Screw* command, additional options will display below the Tool Shelf.

Steps will control the quality of the circular curve (*I used 32*).

Turns is the number of coils.

Center and *Axis* will do some fine-tuning for you.
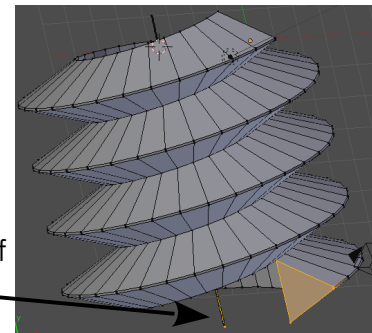
By spinning the mesh, you will be able to select the string of vertices created from the line down the center.

In order to make a spring, you do the exact same thing as the screw, except you use a circle instead of a plane. I will create 2 examples using a short line for close coils and a longer line for wider coils.
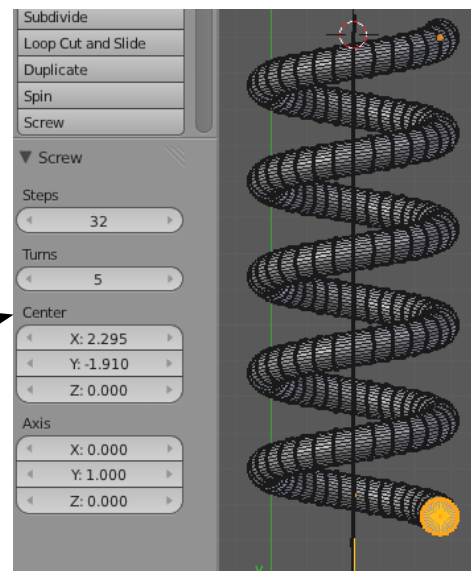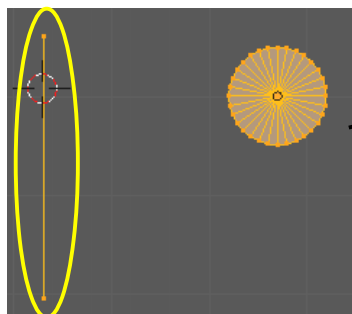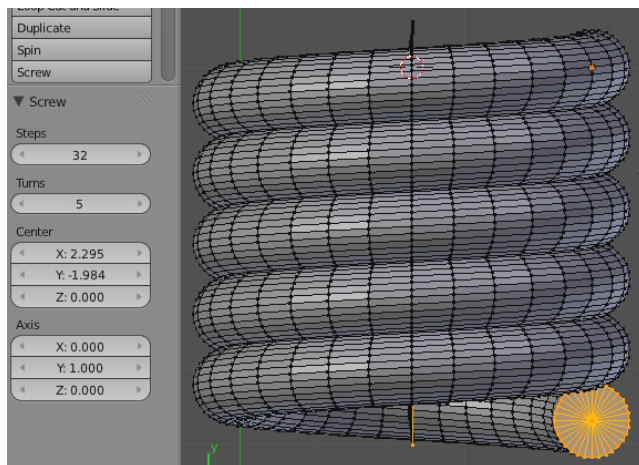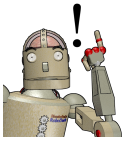
RoboDude Asks: How could I animate a spring stretching and compressing?
Remember how we made shape keys? Scale the shape along the axis and use the slider to animate it. It can also be parented to an armature bone and stretched.

Gears:

Since a gear uses a 3D shape for the tooth and not just a 2D profile like screws and springs, we need to use the *Spin* command for that and duplicate the object as it is revolved. To start, add a cube, switch to a *front view* and shape the one edge to look like a wedge. I selected the 4 right edge vertices and hit "S" to scale and "Z" to scale on the Z axis only. This is a pretty simple gear tooth, but good for discussion.
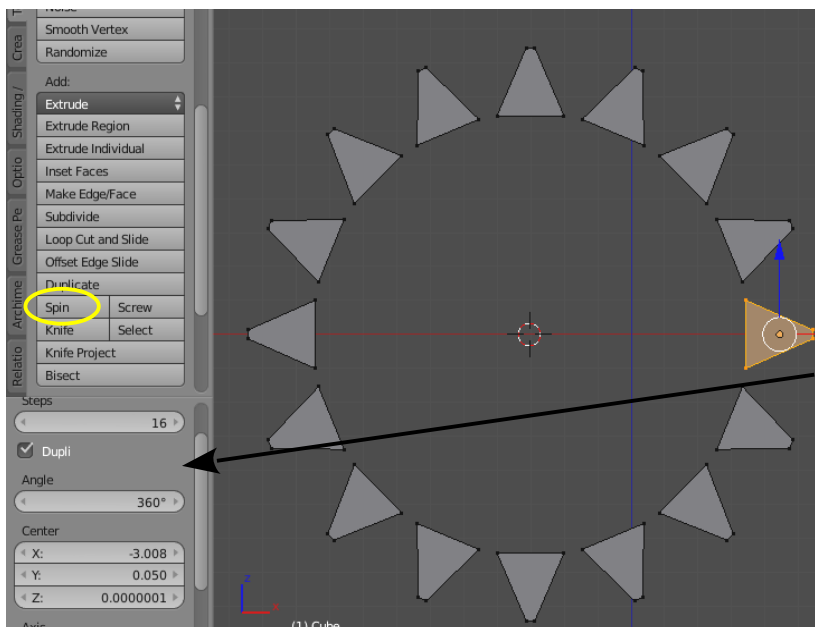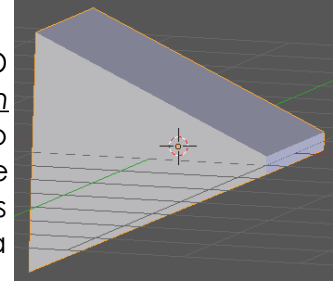
Now move the 3D Cursor to a location where you would like the center to be. (*still in the front view*). Enter *Edit Mode* and select all vertices. In the *Tool Shelf*, select the "*Spin*" command. You will need to adjust:

Steps to match the number of teeth.
Angle to 360 (*full circle*).
Dupli may need to be checked to duplicate vertices rather than spin them.

RoboDude Says: *After spinning an object, you will probably have a double set of vertices over the original tooth. Select all vertices and use the "Remove Doubles" command in the Tool Shelf.*
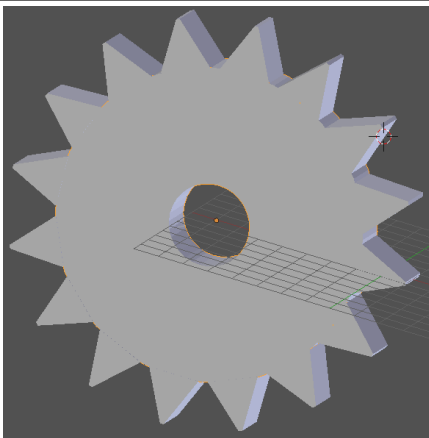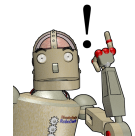
To finish off the gear, add a cylinder to the center and shape/scale it to fit the teeth. You could also use Boolean modifiers to cut holes for more detail. Join the meshes together when finished.

Creating Revolved Shapes

If you wanted to make a revolved shape, like a goblet or an alien flying saucer, you could start with a circle and extrude it to make the shape, but you could also use the *Spin* command.

For this example, I started with a plane, deleted one vertex, and shaped/extruded the mesh into the profile of a goblet. Make sure the 3D Cursor is somewhere on the center axis line of the mesh.
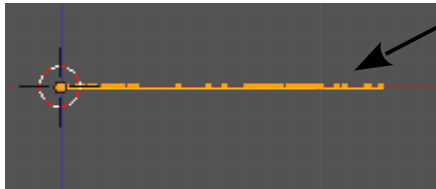
Switch to a front view (or whichever view you need) so you are looking down at the shape and displays as a line. Spinning is related to the view you are working with.
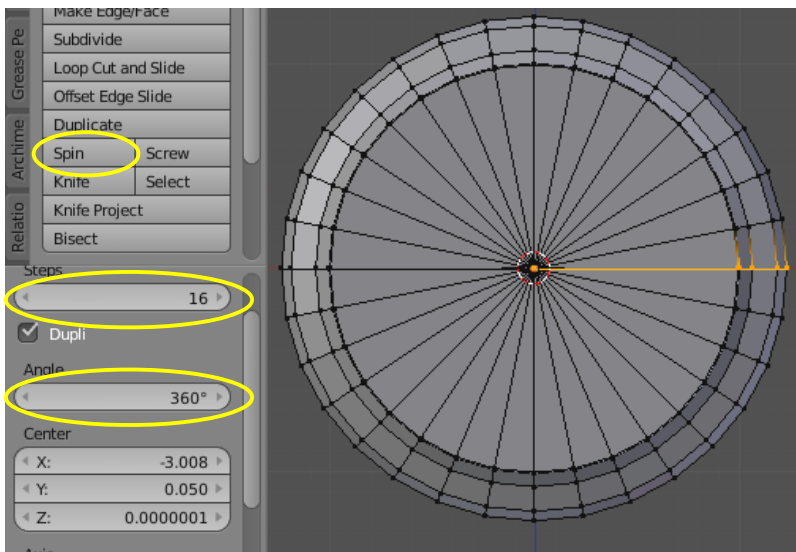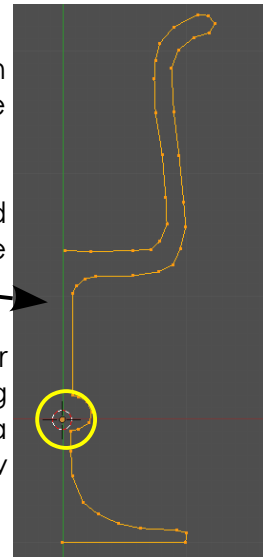
Just like we did for the gear, make sure all vertices are selected and hit the "*Spin*" command. You will need to change the "*Steps*" (*I used 32*), and the "*Angle*" to 360 for a full circle. You will also want to select all vertices and "*Remove Doubles*".
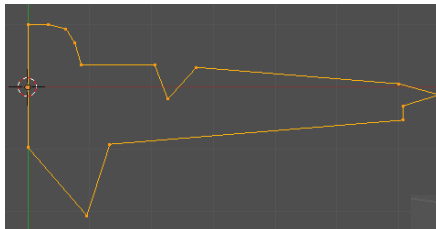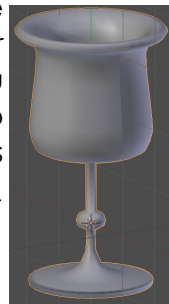
To the left is a profile extruded in the *top* view. The examples show spinning that shape in a *front* view and a *side* view. The active view at the time *does* make a difference!
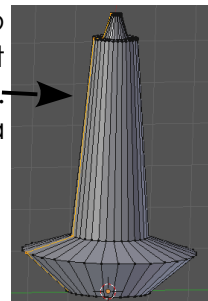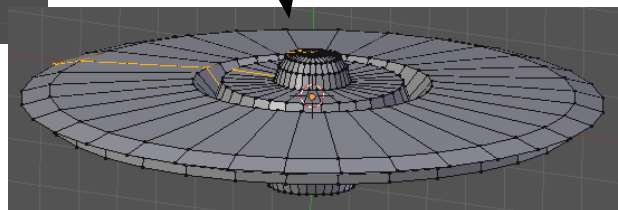
Don't forget- there are Modifiers listed that can do some of these features, only a bit differently. You can actually specify an object for an axis and a few other things. Feel free to experiment with them now that you have a better understanding of how to do revolves.

Blender Add-On Meshes

Using the above techniques have always been in Blender and can work well for making mechanical parts like screws, bolts and gears, but with newer versions, there are now easier ways to do these things. For the past several releases, there has been a script included with Blender called *Bolt Factory*. It worked great for making bolts and nuts, but many users didn't know it existed. Now, you can have that feature (*and others*) appear in the "*Shift-A*" add menu by enabling the "*Add-Ons*" in the *User Preferences* menu. This has been discussed earlier in the book, but here are the details again.

Go to the "*File*" pull-down menu and select "*User Preferences*". In there, you will see a tab called "Add-Ons". There are a lot of nice features you may want to use in there and by checking the box, the script will be enabled. For now, we are checking "*Add Mesh- Bolt Factory*" and "*Add Mesh-Gears*". If you want these enabled at all times, save the defaults. There are also many other mesh types that could be useful in the Add-Ons. There are now architectural elements available as well. These features are pretty simple and easy to figure out, but here are the basics:
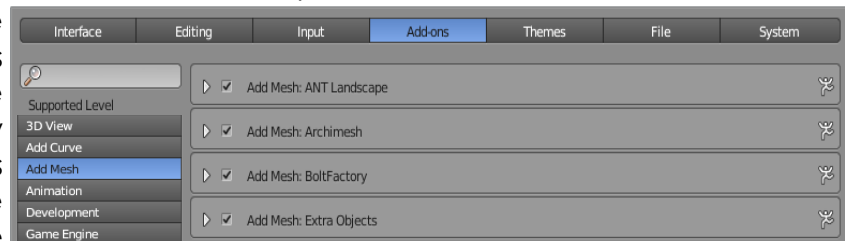
Bolt Factory:
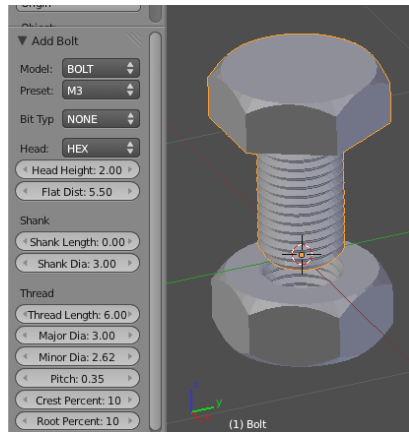
When you hit "*Shift-A*" now, you will see the 2 new options in the mesh menu. By selecting "*Bolt*", you will see a list of options in the *Tool Shelf* area. You can select bolt or nut, a preset metric size, head shape and type, lengths, etc. Almost everything you need for quick hardware.
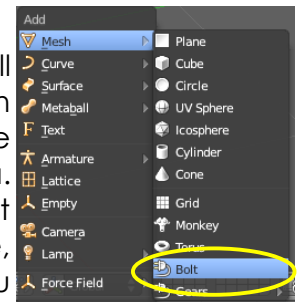
Gears:

There are 2 different types of gears you can add. A *worm* gear and a *gear* (*spur gear*). You have many setting options that can be changed with terminology related to real gear development.
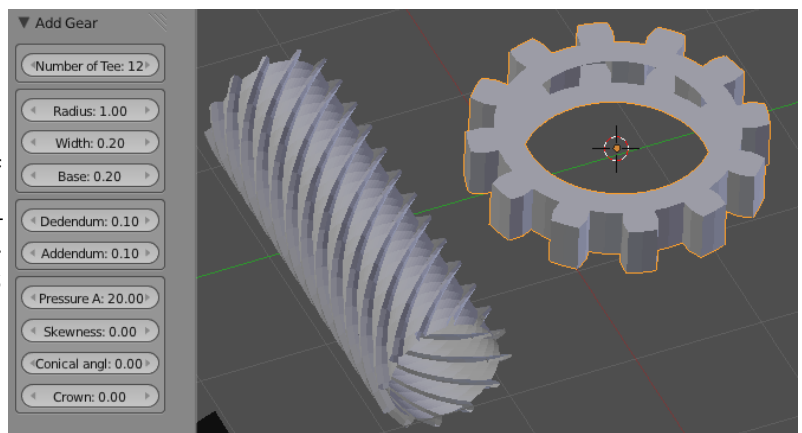
Turning Gears

Create a worm gear and a spur gear to mesh with each other using the information discussed in this chapter. You can use the "*Spin*" and "*Screw*" Tool Shelf commands or use the *Gears Add-On* in the User Preferences. Either method, try to keep the gear teeth equal on each part. Try using the copy command for the basic tooth shape. Add materials, textures and appropriate lighting. **Make a 200 frame animation of the gears turning**. *Try to make them mesh perfectly!* Remember the Linear Extrapolation options available in the **Graph Editor Window**. All you need to do is create a small section of the animation and let the computer do the rest! If you need a refresher, review the animation chapter and page 10-9 for animating the light in the lighthouse.
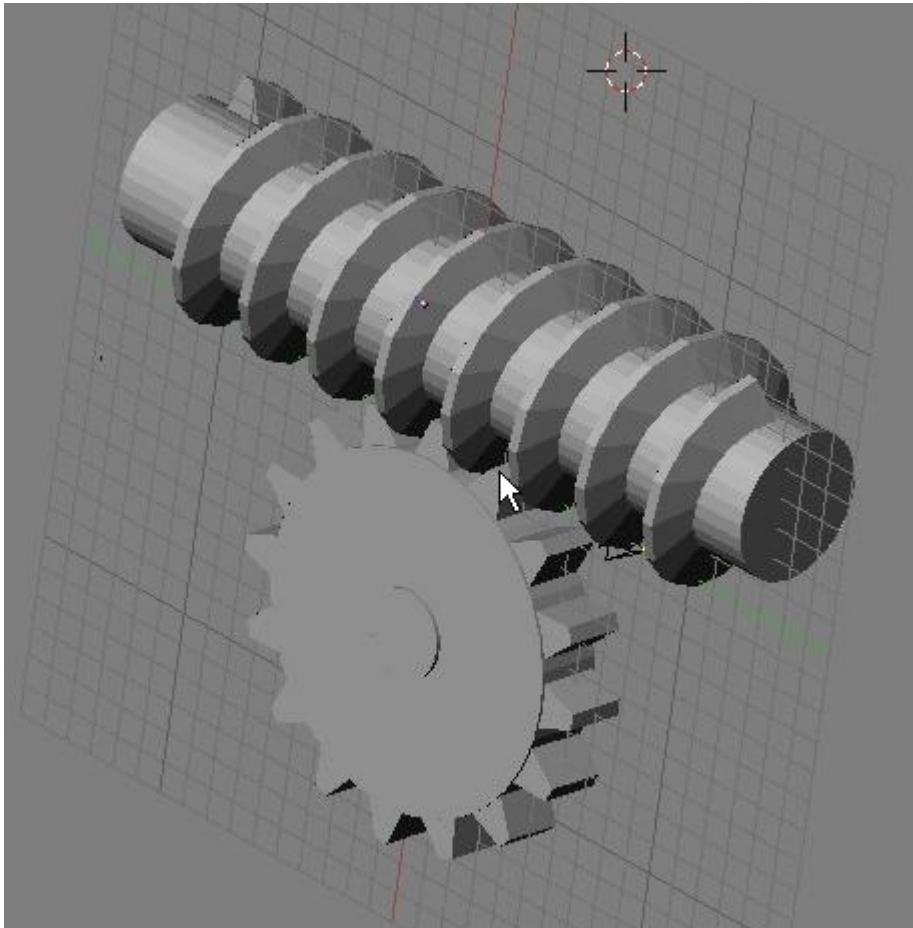
*** Call the instructor when finished***

Scenario:

You have been asked to develop an animation for a new automotive suspension system. You can add as much detail as you wish, but need to demonstrate a coil spring in motion.

Research the internet to find a suspension system you would like to duplicate. Create as much detail as possible with a spring in the system and animate the system. Animate the spring using shape keys or armatures as discussed in previous chapters. Here is a refresher:
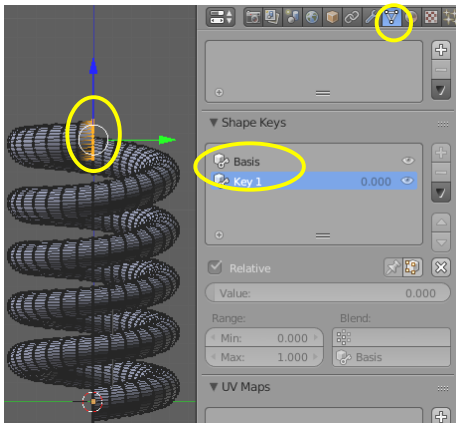
Shape Keys:

After creating the spring, go to the *Object Data* buttons and create a *Shape Key* slider. Enter edit mode, select the top vertices and turn on *Proportional Editing*. Scale the selection area to effect all but the bottom of the spring. Stretch or compress the spring and exit edit mode. Move the slider and animate to change the spring. Refer back to previous chapters if you need assistance.
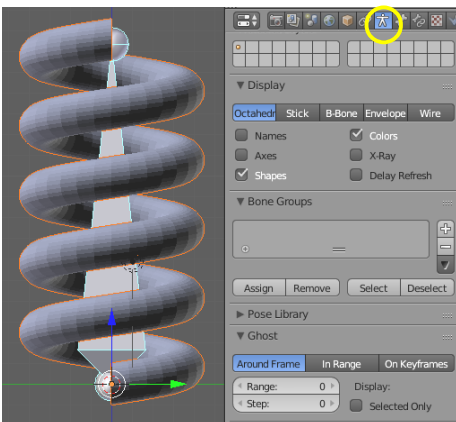
Armature:

After creating the spring, add an *Armature-Single Bone*. Scale the bone so it matches the length of the spring. Go into *Pose Mode* for the bone. Child-parent the Spring to the Bone and choose the parent to *Bone* option. Now when you scale the spring on the Z-axis, you will stretch and compress the spring.

Create a short animation of your scene when finished.

** Call the instructor when finished**

Chapter 20 Reflection and Wrap-up:

Mesh Features and Mesh Add-ons

Mesh spin and screw features and modifiers can save you a lot of time when trying to model spun shapes. So can the mesh add-ons. Take a few minutes to reflect on your experiences.

1. **If you have not done so already, go into Preferences and enable all of the mesh add-ons. Take a look at all of the different mesh shapes you can add. You have everything from geometric shapes to pipe joints to torus knots. Which shapes do you find the most interesting? Which can be the most useful? Why? Explain.**

2. **Review the architectural meshes that have been recently added to Blender. Find a YouTube video that demonstrates their use. What could be a good possible use for these tools for a personal project? Explain.**

3. **If you were to make gears of different sizes that needed to mesh together perfectly, how could you do it? If gears are different diameters, are the gear teeth the same size? Should diameters and number of teeth be proportional? Research these questions and explain your answers.**

Video Motion Tracking has recently become a strong feature in Blender, giving the program the ability to rival other professional programs used to create composite CGI feature films. This feature adds to Blender's ability to be a one-stop-shop for video creation and editing.

Camera and motion tracking allows you to load video footage of some real-life scene into Blender, track various points in the scene in Blender, then analyze this tracked data to turn the movement into a 3D virtual scene. You can now add your own 3D modeled objects and merge the CGI with the real footage. With practice and patience, you can create scenes that will rival the Hollywood blockbusters!

Setting Up the Tracking Scene

Getting Started:
The first step is to film the scene you wish to use with your 3D models. Obtain the highest quality video possible for the best results. Think ahead and plan for lighting, foreground/background elements, and smooth camera motion. The video will need several high-contrast points (markers) in the scene that will be used to create the Blender camera path. Blender will track these point throughout the video in order to determine the camera's location, target depth, and zoom. If your scene does not have natural high-contrast points, you may need to add them (small white paper dots on a dark surface, coins, tape, etc). If you know where your 3D objects will be placed, your markers can be placed in those locations and be covered by the 3D objects in the final video.

Blender is able to use many different video formats. Since most phones and digital cameras use the .mp4 format, Blender is able to use videos in this format. Video quality that is too poor or with mismatched frame rates may not work well. It is best to convert the video to match the size and frame rate to what you plan to use for your final composite video output before tracking the video. This can be done through a video converter program or in Blender's video editor that is discussed in Chapter 24. For our practice video, we will use this simple desk scene.
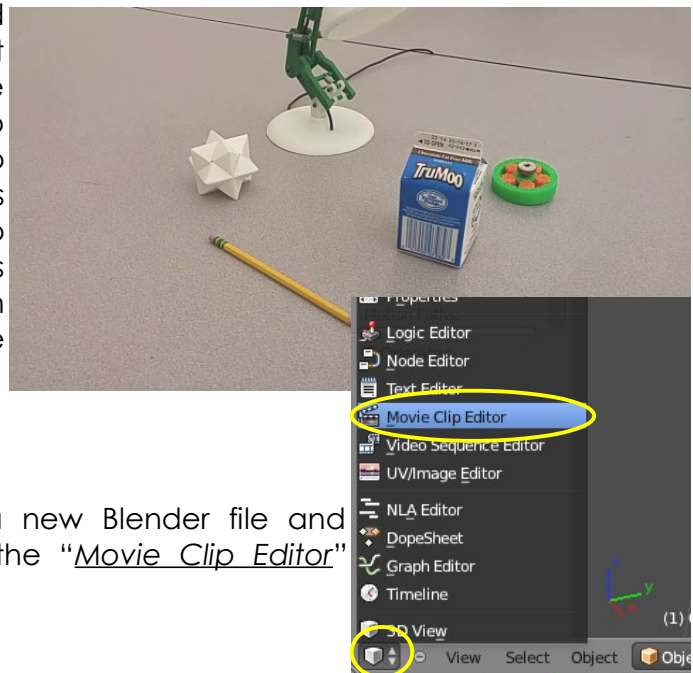
Adding the Video:
After you have your video, open a new Blender file and change the "*3D View*" window to the "*Movie Clip Editor*" window.

At the bottom of the window you will see an **Open** button. Open your video. It should now display in the window.
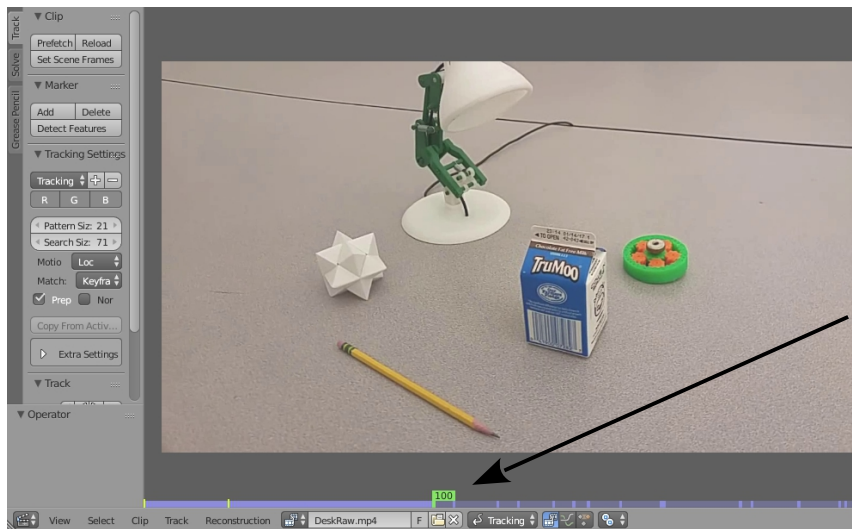
Adjust your **End Frame** to match the video length. In order to play the video, hit "**Alt-A**" or the bottom "**Play**" button. As the movie plays, you will notice a small blue bar at the bottom of the window with a small lighter blue area following the marker. This small area represents cached frames in memory. We need to adjust this so all frames are cached in memory.

In order to adjust the cache, go to the "*File*" menu and select "*User Preferences*". In User Preferences, go to the "*System*" tab and find the **Memory Cache Limit** setting under Sequencer at the bottom of the display. The default setting is 1024 Megabytes which only caches about 250-300 frames. You will need to adjust this setting so all frames in the sequence are cached for smooth playback and operation. Try dragging the setting all the way up to the highest limit that your computer will allow. If you find your computer is sluggish, try adjusting the cache down until you have as much as needed or try to exit other programs that may be running on your computer.
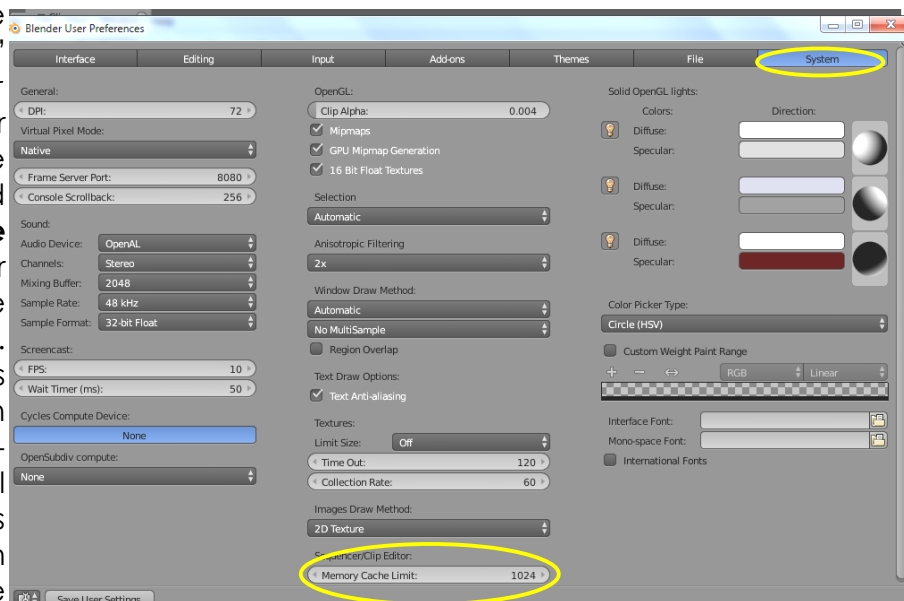
By pressing "Alt-A" or the "Play" button at the bottom of the screen should now display the entire bar light blue, indicating that all frames are now cached in memory. It is now time to start the tracking process.

Adding and Adjusting Markers:

Markers are used to track the camera motion and can be difficult to adjust. Here are some of the basics to use when placing markers:

Add Markers- *Use this to place a marker on a high-contrast area.*

Pattern Window- *Shows the pattern size of the selected marker.*

Delete Track- *Deletes a marker*

Tracking Settings- *Adjust the marker settings. Discussed in the next section.*

Pattern & Search- *Check these boxes to display the Pattern and Search areas of screen.*

Track- *Use the play arrow to create a track of the marker. The Clear button can be used to clear a track to try again.*

Marker- *A marker that is displaying the Pattern box (the contrast area to track) and the Search box (the area to search for the pattern while playing through frames).*

By clicking the small triangle in the "Tracking Settings" box, you will see a few setting you may need to adjust as you add markers. While most settings should work for most scenes, results can be improved by changing the following:

Pattern and Search Sizes- The pattern size should be large enough to cover the entire marker you are using, but not too large so that it includes a large area around the object. The search area is where the computer will look for the marker from frame-to-frame. If you lose the marker when you try to create the track, try adjusting these. The quality of the movie, contrast of the marker, and amount of motion will vary for all of these. Larger pattern and search sizes will slow the system.

Match- Less errors will occur if you change the frame matching from Keyframe to Previous Frame.

Correlation- Controls how tightly the camera tracks the marker. The default of 0.750 works for most videos, but can be lowered if your video quality is poor and has trouble creating a good track.

Margin- As some of your marker approach the edge of the frame, they will "float" at the edge. Try setting the margin to 5 to prevent errors.

Chapter 21- Video Motion Tracking

The more markers you add, the better your camera will track. Not all marker areas may work well so you will need to experiment with pattern and search sizes for each marker. Depending on your scene, some markers may go off the screen during the video. This is fine and will still help create your camera track. The more markers you can create that remain on the screen during the entire playback, the better. Markers can be moved and scaled with normal Blender commands ("G" and "S"). Remember to use "Alt-A" to show animation.
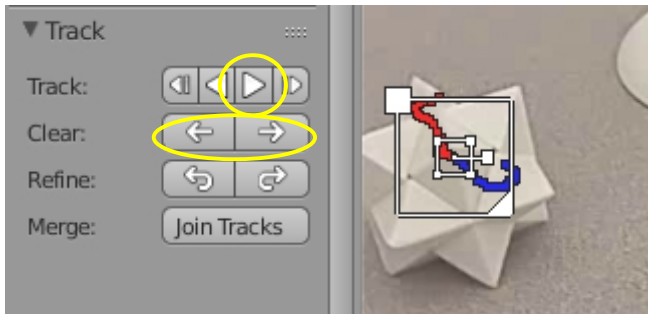
As you add a marker, press the *track selected markers* button (triangle) to record the tracking. If it fails, try adjusting the marker, clear the track, and track again. You can clear before or after the current frame. *If you have placed several markers and want to track them all at the same time, make sure they are all selected.*
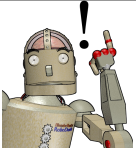
RoboDude Says:
Always make sure you are on frame 1 when adjusting markers! You can also add markers quickly by pressing "Ctrl-LMB" in the video window.
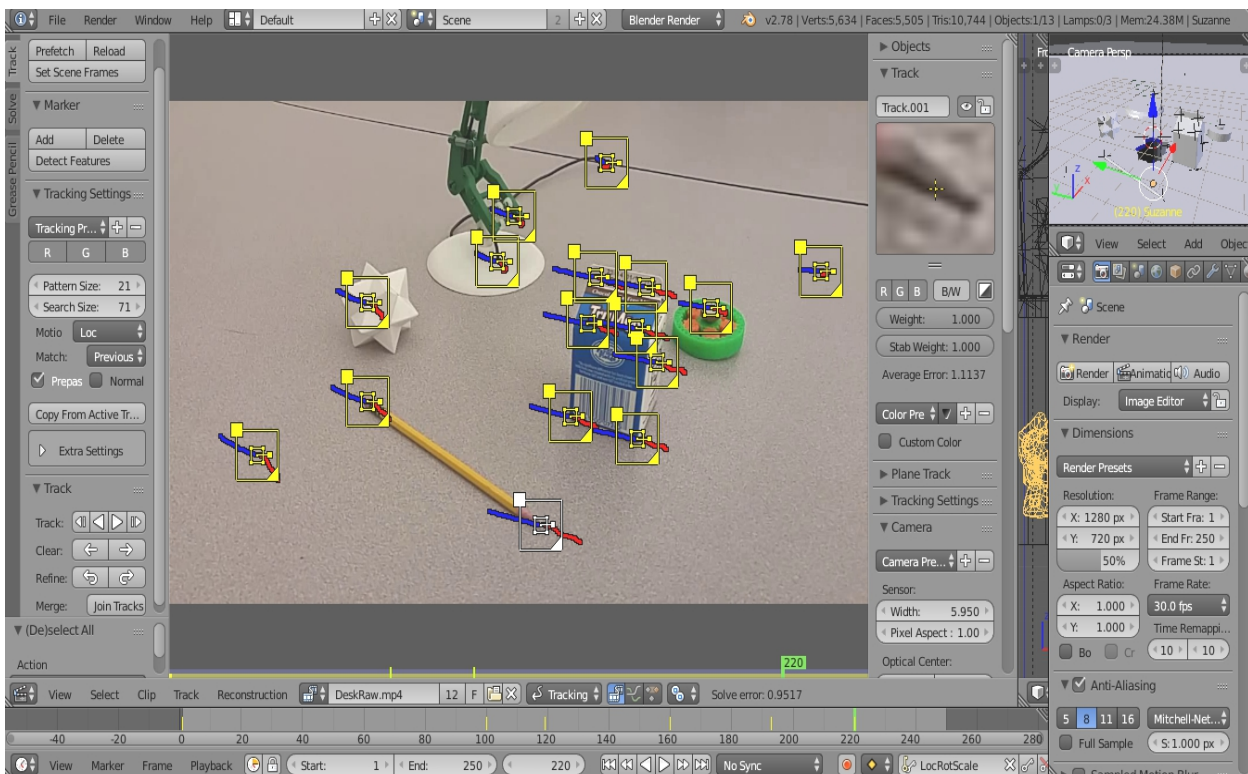
Here is our test scene with several markers added and tracked. You will need at least 8 markers for accurate tracking. More is better. If you plan to track an object in the scene to add CGI to it (*like a mask or hat on a person*), You will need to track that object as

well with at least 8 markers. If you go over to the right side of the screen, you will see an "Object" panel at the top of the menu. By default, you have tracked the camera to determine it's motion. Press the "+" button to add an object to track. The Camera tracking markers will disappear so you can start tracking the object.

It is now time to create the camera path to use with our 3D models.
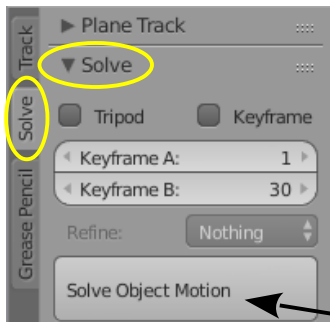
Exporting the Camera Path Data:

After the points have been tracked, it is now time to set up the camera data so the path can be exported to your 3D scene. On the right-hand side of the viewport, you will find the *Camera and Lens* settings. You may need to do some internet research to find some information about the camera used to create the video. For best results, the Focal Length, Sensor Width, Pixel Aspect, and Optical Center should be set as closely as possible to the camera used. There are also several *Camera Presets* available to chose from. While Blender attempts to keep the preset list up-to-date, it is usually running a model or two behind the current cell phones on the market.
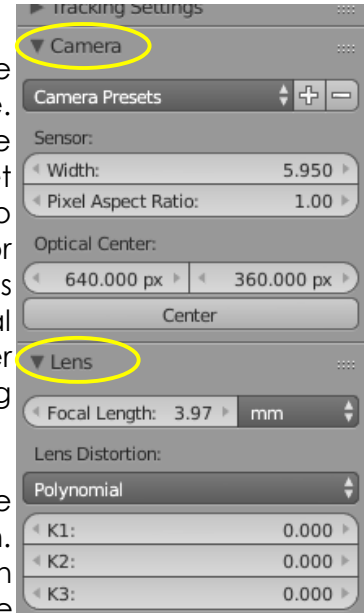
Another setting that you should adjust at this time is in the **Solve** panel on the left side of the viewport, second tab down. Find the two blocks that deal with **Keyframe A and Keyframe B**. These setting are used to tell Blender where there is significant forward movement in the video. For example, if between frames 65 and 86 the camera operator took 2 steps forward. This should be set as Keyframes A and B in this panel. This will help Blender calculate camera position. Scroll through your video to determine any forward movement. If the camera was used on a *tripod* with no forward motion, select that option.

You are now finally ready to press the "**Solve Object Motion**" button (also in the Solve panel) to calculate the camera path. You will see a percentage bar at the bottom of the viewport as Blender processes the path. After the path is processed, you will notice a **Solve Error** message at the bottom right side of the viewport. You goal is to have a number as low as possible for a high quality motion path. Anything less than 1.00 is considered excellent while anything less than 3.00 is considered good. This scene shows an error of 0.7547 which should be good. If the error is very high (3-40 or more), you may need to check your camera data settings (focal length and sensor width) or redo your markers. It is a process that gets easier over time and use.
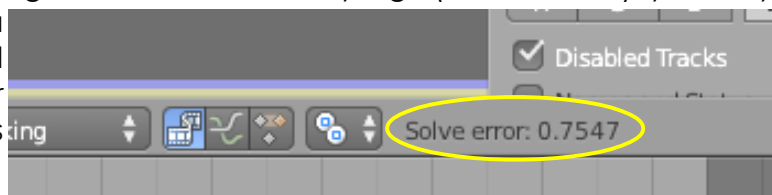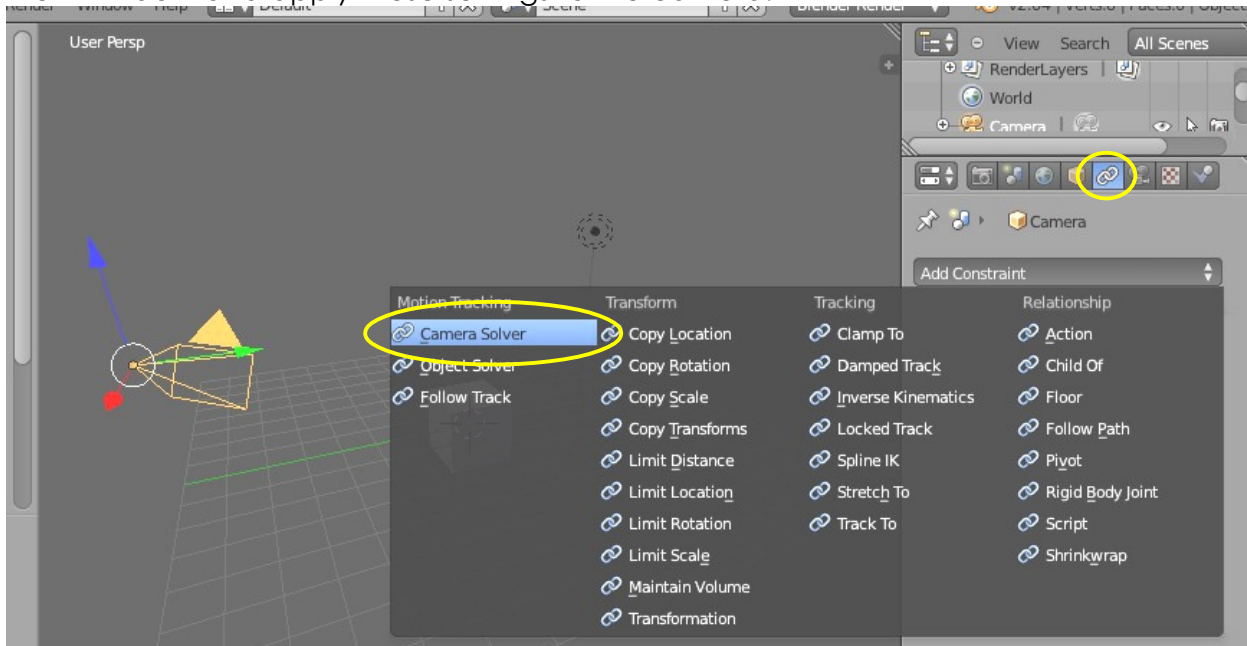
Using the Camera Path in the 3D Scene:

Now that you have calculated your camera motion, it is time to switch back to the 3D View window and apply these settings to the camera.

Select the Camera, go to the **Constraints** panel, and then add a **Camera Solver** constraint. You will immediately see points (represented by empties)on the screen that represent your markers (*depends on your Blender version. If not, we will fix that in the next step*) and when playing the animation, your camera will move as the actual camera did when filming the video. It is now time to refine your scene so it will be easier to work with 3D elements.
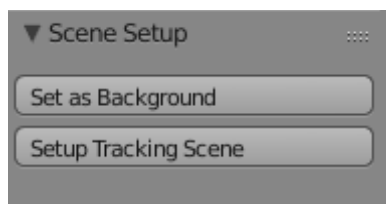
Go back to the **Movie Clip Editor** window (*or split your screen so you can have a 3D View window and a Movie Clip Editor window open together*). Find the panel on the left called "**Scene Setup**". By clicking the button "**Set as Background**", your 3D View window will now display the video in camera view (*0 on number pad*). If you do not see your points in the 3D View, click "**Setup Tracking Scene**". This should display your points and may also give you a floor plane. By pressing play, the points should align with where your markers were located in 3D space.

Aligning the Scene:

You now have a camera path and points, but you will notice that they are not aligned with the grid and a few points may be higher or lower than the others. To correct this problem, we need to move the entire scene to the grid level and align it correctly.
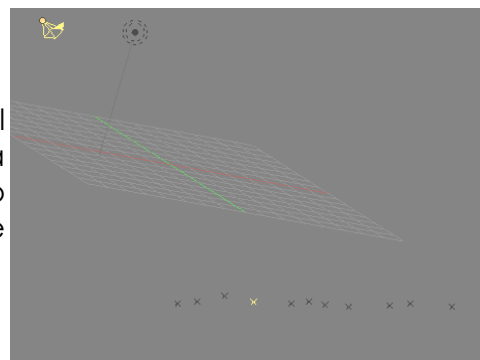
To align the points (floor) to the grid, you will need to make some more adjustments in the *Movie Clip Editor* panel. In the left panel, close to the Scene Setup options, you will find a panel called "Orientation". We can use these options to align various points in your 3D scene and also set scale.
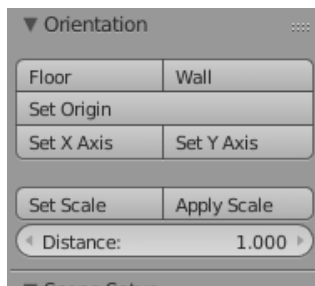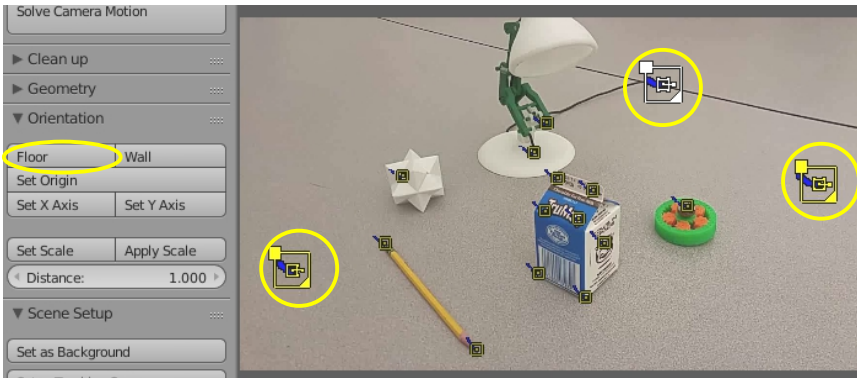
Select 3 markers in your scene to use as a floor reference. Select points that have some distance between them. With those 3 points selected, press the **Floor** button in the left side panel. This will move the points onto the grid in the 3D View window. You can also select a marker and set as **Origin** to center the scene. Points can also be selected and set as **Wall**. Scale can also be set by selecting 2 points, changing the "*Distance*" and pressing the "*Set Scale*" button.

RoboDude Says:
It may take a little trial and error to get your scene set up and tracking well. Experiment using different marker points and scales. Try also setting an origin.
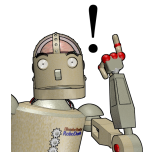
Setting Up Objects for Your Scene:

You are now ready to start adding your 3D objects. If you did not press "**Setup Tracking Scene**" in the previous steps, do so now. By pressing this button, your 3D View window will now get a plane and cube set along the floor line. These objects will be placed in a different layer, set as a mask. Basically, objects in this layer do not render, but will display shadows cast upon them. This is how your 3D modeled objects look like they belong in the actual scene. Masks and material settings will be discussed in the next section. You are now ready to begin creating 3D objects in your scene. Some may be set to render and some may mask objects so it looks like your 3D objects go behind objects in the video.

Using Masks and Materials

When you added the tracking scene, Blender placed the plane into the bottom layer. It did this because Bender set that layer up as a masking layer and also considers it a Background layer in node rendering. Basically, anything placed into that layer will not render. You can see this by going into the *Render Layers* properties panel.

Creating masking objects that receive shadows using the internal render engine materials is a simple process. For the example below, in the tracking plane that was added as our floor, I create a hole by subdividing the plane, deleting some vertices, then reshaping the hole to look more jagged. A material was added to the plane. In the material "Shadow" panel near the bottom, The only items needing checked are "*Receive*" to receive shadows from other objects, and "*Shadows Only*" so the only thing the plan displays in the rendered view are those shadows it has received.
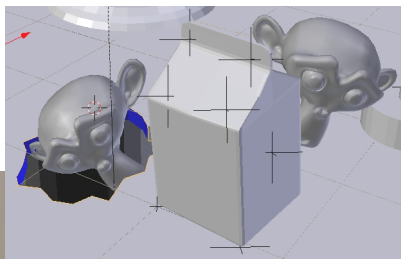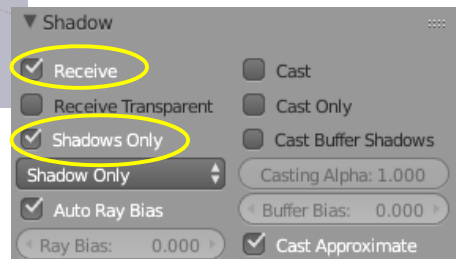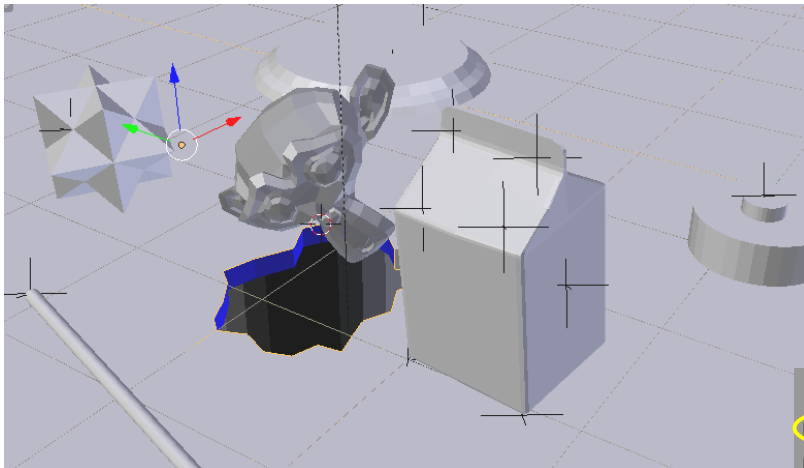
You will notice that a model of the milk carton and other objects were created to match the items in the video as closely as possible. These objects are being used as masks so if the monkey head passes behind one of them, it blends perfectly with the scene, making it difficult to tell what is real and what is CGI, as displayed to the left.

Scenario:
You have been hired to work on a soft drink commercial requiring a CGI video using a real desk scene. Your goal is to create a 300 frame movie (10 seconds @ 30 fps)using camera motion tracking.

For this project, create a Blender file called "Motion Tracking", using your standard video default settings. Your steps are:

- Create a 10 second video of a desk scene, or use an instructor provided video.
- Convert the video to match your final output settings.
- Create your tracking scene in Blender. Research your camera's settings for accuracy.
- Develop your 3D models, materials, lighting, and appropriate masks for your video.
- Save a 10 second video of your final work.
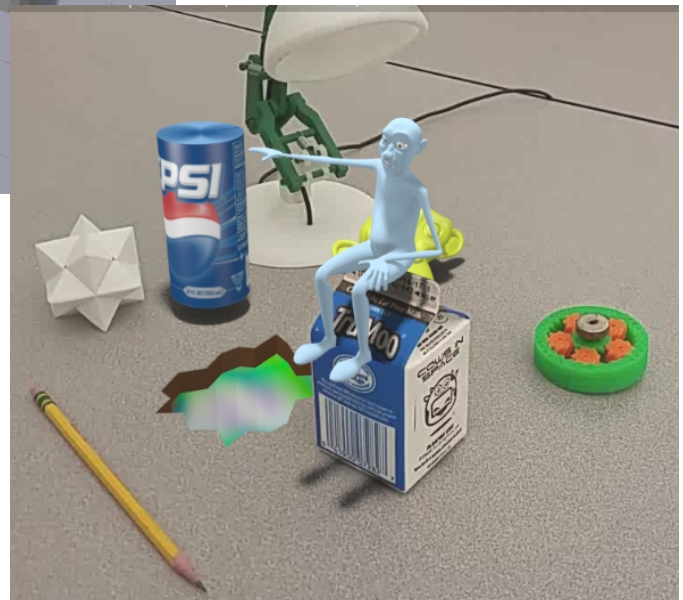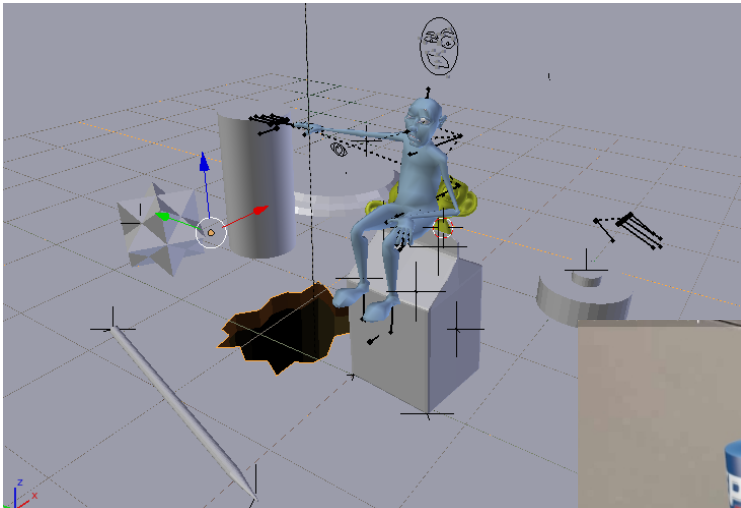
** Call the instructor when finished**

Chapter 21 Reflection and Wrap-up:

Is it real or is it CGI?

Adding realistic-looking 3D elements to a real video is common place in movies, TV shows and advertisements these days. So much so, that it is becoming impossible to tell the difference. Many of the car commercials you see today use 3D models of cars instead of the real thing, but you can't tell the difference. Please take a few minutes to reflect on your experiences with motion tracking.

1. **After creating a simple motion tracking scene, what were your biggest challenges and how did you overcome them? Explain.**

2. **What did you find to be the most interesting aspects of this project and why? Explain.**

3. **Research the internet to find some examples of motion tracking. What would you like to attempt to do with motion tracking in a possible future project? Why?**

4. **Find the Blender Open Movie "*Tears of Steel*" on the internet. "*Tears of Steel*" was developed by the Blender foundation to highlight development of the motion tracking tools. Which features of the movie did you find to be the most interesting and realistic? Which ones seemed like a low-budget sci-fi movie effect (cheesy or not very realistic)? Explain your answers.**

So how can you make 3D games with Blender? Also considered real-time animation, the game engine has been around for many years and uses the Bullet physics engine like all of the other physics animation tools previously discussed. Even though we have already discussed using the Rigid Body physics in animation, the physics in the game engine actually give you some more options, plus having the ability to control those objects through logic blocks. The Blender game engine uses a programming language called *Python*. Can you make nice games in Blender without knowing Python? The answer is "yes", but if you want to reach a more professional level, knowing Python is a definite. There is a lot of nice documentation on the web for learning Python.

Setting Up The Physics Engine

Let's say you want to use physics to make a ball bounce realistically using tools similar to what we used in chapter 19. The 1st thing you need to do is set up the scene. For my sample scene, I have created a UV Sphere a few Blender units above a plane in a front view. Remember that this scene will be using gravity and reactions. If you make your scene in the top view laying flat, it will work just like real life.

Top View

Front View

It's now time to set up the real-time animation. The real-time game engine in Blender has changed quite a bit over the years. Here's what you need to do:
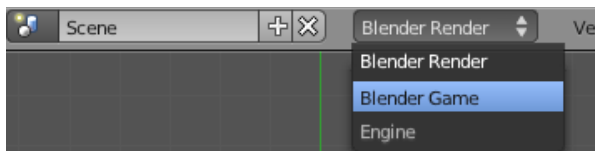
To enable the Game Engine physics, go to the top bar and find the box for the *Render Engine*. Change it from "*Blender Render*" to "*Blender Game*". This switches many of your property tool panels to game engine options. We are interested in settings in 3 of these panels:
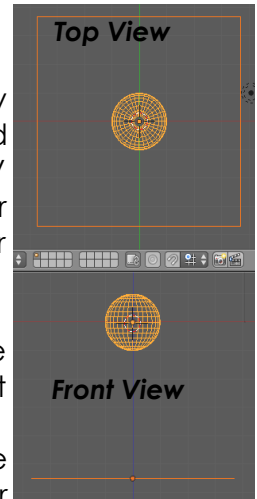
Physics Panel:
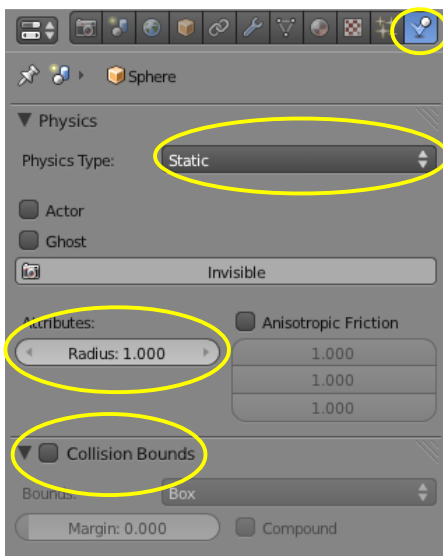
In the Physics panel, you control the *Actors* in your real-time animation. By default, everything is "*Static*" (*unlike using Rigid Body object in the render engine, where nothing is set as passive by default*), meaning that it doesn't react to the physics settings except to have things bounce off them. They can still do things when logic blocks are applied to them, but do nothing otherwise. The other 2 main types we will discuss later are "*Dynamic*" and "*Rigid Body*" actors. When set to rigid body, it will act similar to objects discussed in chapter 19.You can also make something invisible here.

Two other important settings are "*Radius*" which controls the actor size and "*Collision Bounds*" which sets the shape of the actor. All of this will be addressed later.

Chapter 22- Game Engine Basics

World Panel:

The most important setting for the game in this panel is the "*Gravity*". By default, it is set to real gravity, but what if you want to make a game set in space where gravity isn't an issue? You will want to set gravity to zero or something really low. This is where you can set the speed of the game (FPS) along with other typical settings that work in the game like Horizon color or even a mist.
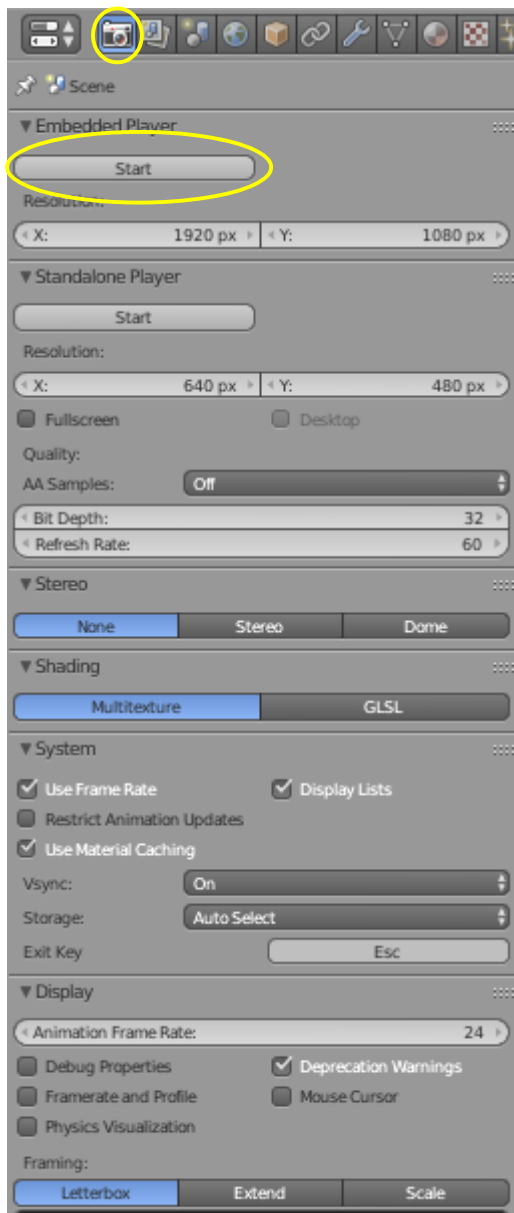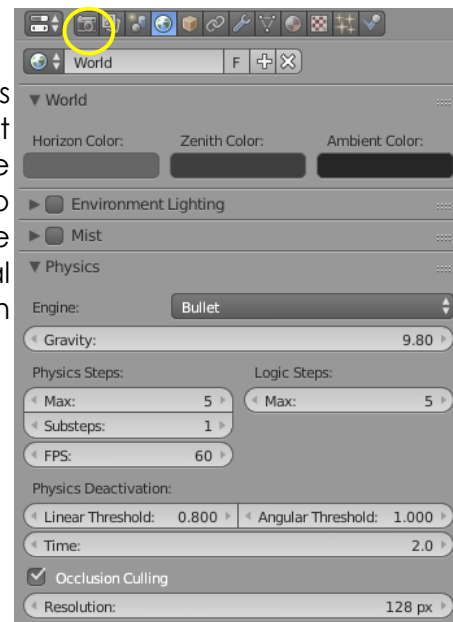
Render Panel:

Just like rendering a picture to see your output, this is where you enable the game to play. You can press the "*Start*" button here or just press "**P**" to play in a viewport.

Your end result of making a game is for that game to be played as a standalone (*not in Blender*). This means saving the game as an executable that can launch itself, free of Blender. You can set the size of the game, the color depth, Frames-per-second (FPS), and full screen effects.

There are also many other settings here that deal with the shading engine used, how lights and shadows are displayed, and more.

While not in this panel, but the *Scene* panel, games rely heavily on sound effects, the game engine has setting features that deal with how the sound is played as well.

It's now time to apply some physics to the sphere. Add a *Cone* to the scene so the ball has something to deflect off of as it falls. Switch to a shaded view and select the UV Sphere. Rotate your view slightly so you can see what happens when we apply the physics. You want to see the ball drop and how it drops. Now go to the *Physics* panel so we can change some setting.
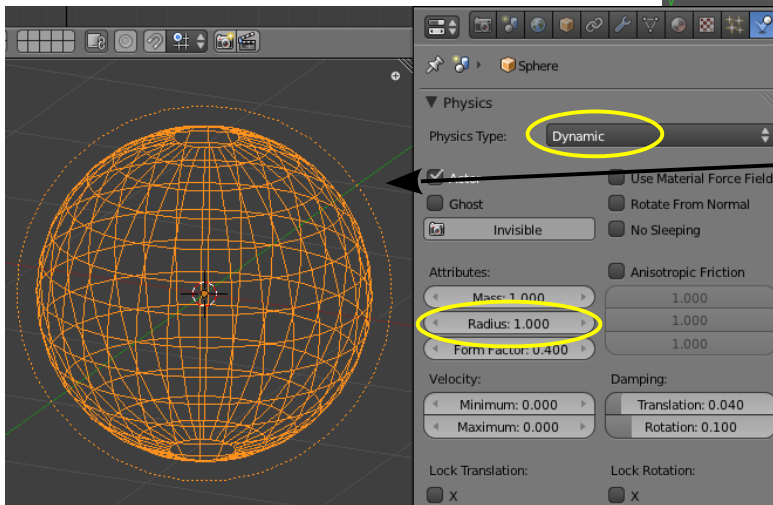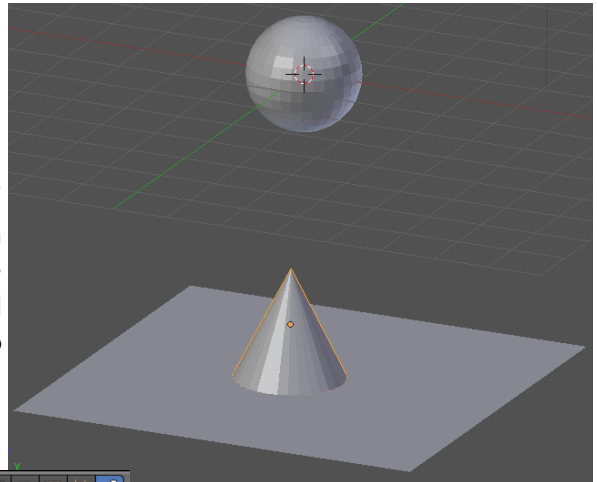
Change the *Physics Type* to "*Dynamic*". If you are in wireframe mode and scaled the sphere down in size, you will see a dashed circle around it. This circle represents the actual size of the actor. You will need to change the "*Radius*" setting to match the size of the sphere. If this circle is larger than the sphere, when you play the physics, the ball will hover over the plan and never touch it.
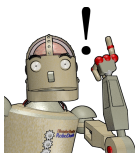
*RoboDude Says: The game engine likes actors (radius) to be a size of one whenever possible. If you scale it down and also scale the radius circle to match, it may still not work correctly. Pressing "**Ctrl-A**" and applying a reset to the Scale and Rotation can usually correct this problem.*

It's now time to test out the system. Switch back *Solid* display mode. With your cursor in the 3D viewport window, press "**P**" to put Blender into game play mode. The ball should fall and hit the cone, but it probably won't act quite right. Depending on where you placed the cone, it may even balance on the top of it! If that happens, move the cone slightly to one side and try again. The ball hits the cone, then slides down. It doesn't rotate like a real ball. To exit game play, hit "**Esc**".
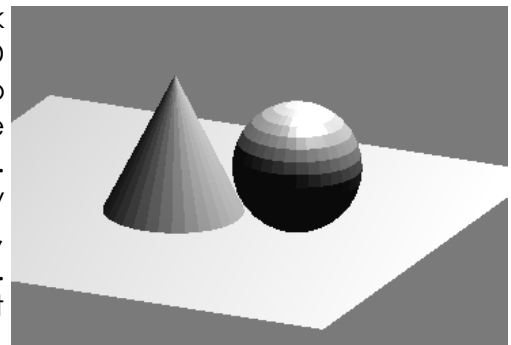
Dynamic and Rigid Body Actors:
A *Dynamic* actor allows you to use physics on it and can fall, bounce and be pushed by forces, but not act like a true solid (*rigid*) body. These actors are great for games

where you need to drive or run around in a maze or other scene. A *Rigid Body* actor will behave like a real solid body, as we experienced already in chapter 19. It will spin and deflect when it collides with other objects. Good for some things in the game engine, but better for creating animations like a brick wall collapsing and things bouncing around.

Now change the sphere into a "*Rigid Body*" actor and hit "**P**" to test out the system again. The ball should now roll off the plane and fall into nothingness. Press "*Esc*" to exit. Feel free to experiment with some of the other setting like *Mass*. Just like real life, if 2 objects collide with different masses, one will feel the effect more than the other.
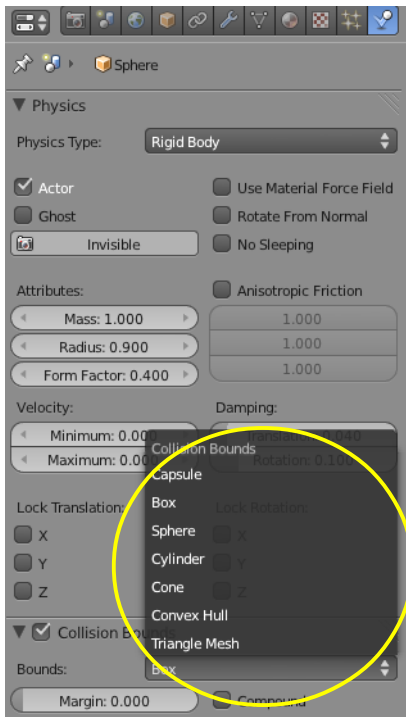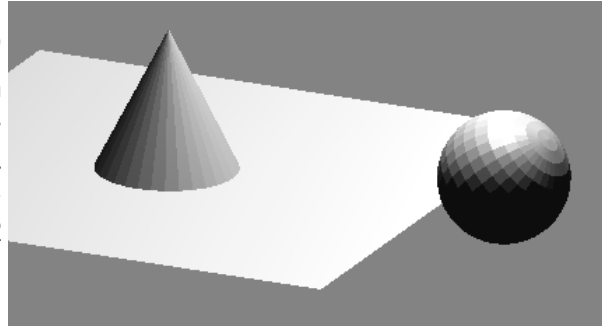
Since you are working with a sphere, you don't notice that even though we are using a rigid body, the actor physics are still calculating to the *Radius* setting in the *Attributes*. If you were to delete the sphere and use a Cube instead, it would roll off the plane like the sphere did. To fix this, you need to turn on "Collision Bounds", as mentioned in chapter 19, and choose a bounds option. "*Box*" would be good for a cube mesh while "*Convex Hull*" or "*Triangle Mesh*" would be better for a more complex shape. You would need to experiment to see which works best for your model.

As you watch your physics in action, you may notice some other reactions that seem a bit off. For example, the ball may slide a bit, or not enough. It may not bounce much or it may spin too much, or not enough. We have 2 places where we can control some of these factors. The first place is in the Physics panel. You will find a block for *Dampening*. The "*Translation*" slider controls the amount of sliding in a direction (like being on ice) while the "*Rotation*" slider controls resistance to spinning. These 2 features will be discussed more when we talk about making a game.

RoboDude Asks: *Why does Convex Hull work better for some meshes while Triangle mesh works better for others?*
Convex Hull basically takes the outline of your mesh while Triangle Mesh will closely follow the mesh vertex shape. With any 3D game, you will need to keep your physics as simple as possible to keep it playing smoothly. Triangle Mesh will provide more accurate collisions, but at a cost in processing. How good does it need to be?
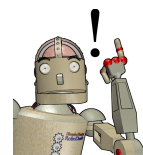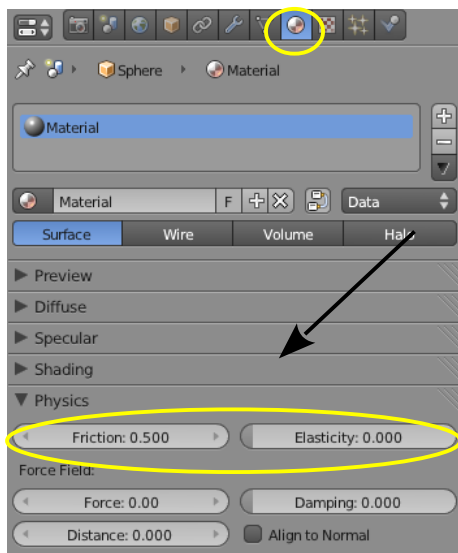
The second place to make changes to reactions is in the **Materials** panel. Add a material to the sphere. And find the *Physics* settings. If you want something to bounce, adjust the "*Elasticity*" slider, "*Friction*" controls slippage. You can also provide *forces* and other *dampening* here as well. *For these to work properly, you usually need materials set on both interacting objects (ex. Elasticity on both the sphere and the plane).*

Materials in the Game Engine:
Some things that work in rendering do not work in the game engine while other features do. For example, a standard image texture may display in the game engine, but many adjustments to that texture may not work. There has been a lot of development in texture work for the game engine and we will examine some of that in the UV mapping chapter. For now, just work with straight Diffuse material color. To see what things will look like in a game, change your view type from "Solid" shading to "Textured" shading. Press "**P**" and your view will reflect what will be seen in a saved game. Since the next section deals with applying game physics to an actual saved animation, texture can be handled exactly as we have in previous chapters.
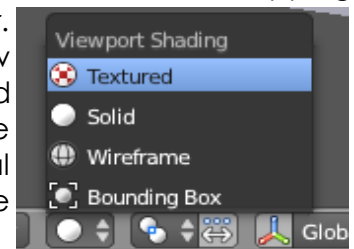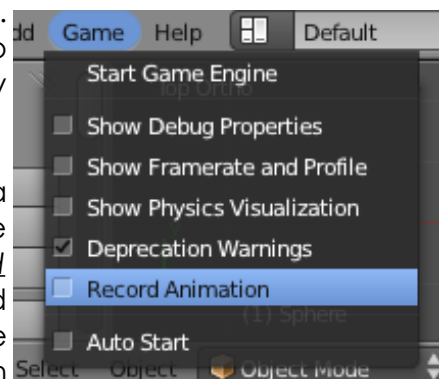
Using Game Physics in Animation

So far, you have a ball dropping on a cone and rolling off the plane. It works when you press "**P**" to enable the game engine, but what if you want to use this reaction in a movie? If you press "**Alt-A**" to play an animation, nothing happens. That is because the reaction has not been written into an animation curve... yet. This is an alternate way to save a physics reaction to the methods discussed in chapter 19 in the Rigid Body physics section.

Writing the game physics to an animation curve is a simple process. In order to write to a curve, go to the "*Game*" pull down menu and select the "*Record Animation*" option. This will enable the game record feature. Now, press "**P**" to run the game engine. Let the physics run through, then "*Esc*" the game engine. Go back to the "*Game*" menu and turn "*Record Animation*" off. You should also change the *Engine* back to "*Blender Render*". You can now test and adjust your newly saved physics as standard animation curves and keys.
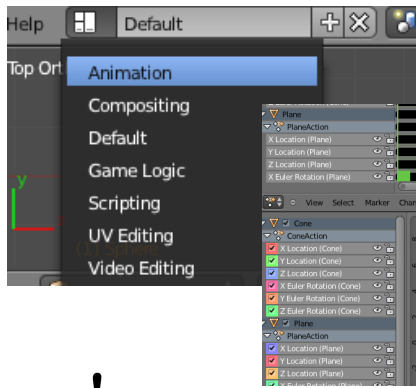
Let's see if it recorded the animation. Switch your screen layout to "*Animation*". You should see animation curves in the *Curve Editor* window. Press "*Alt-A*" to confirm the animation. You can now work with your scene exactly as you would for any other animation work including materials and textures.
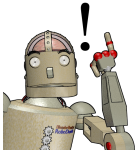
RoboDude Says: Remember to TURN OFF the "Record Animation" feature after you have recorded your motion. If you leave it on and accidentally press "P" again, it will try to over write your saved animation curves!

The only problem you may encounter when saving a movie file will involve the *speed* of the animation. The physics may be run slow in the final movie. This can be corrected in several ways.

Method #1: Remap the timing in the Render panel.
Find the "*Old*" and "*New*" mapping settings. If you need the movie to run twice as fast, set "*New*" map to 50 (50%) and adjust your *end frame* to half. If you need it to run slower, like ½ speed, try a new map of 200 and double your end frame.
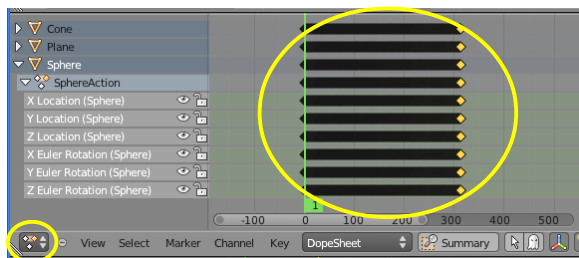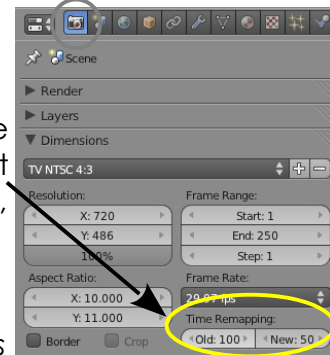
Method #2: Scale Keys in the Dope Sheet.
Another method is to select *All* keys in the *Dope Sheet* window and *Scale* them in the "*X*" axis (*"S" to scale and "X"- drag the mouse*).

Using Logic Blocks
We have talked about using the physics for animation, but now it's time to look at using Blender for *Real-Time* animation like an architectural walk-through and yes, *games*.
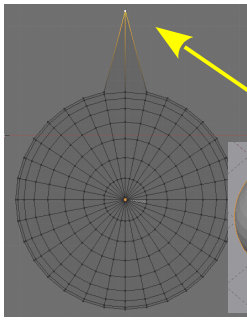
Scene Set Up:
Start a new scene and make a Cube resting on a plane. Using the "**N**" key to open the *Transform* bar, change the scale X of the *Cube* to 0.200. We'll use this as a wall block. For the *Plane*, scale the X and Y to 10.000. This will be our floor.
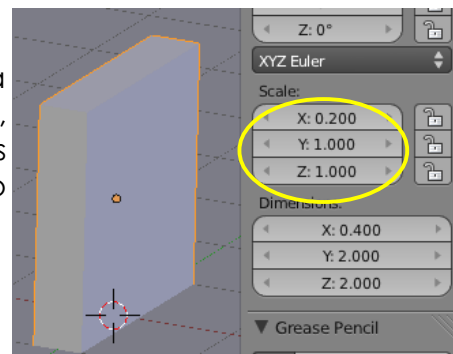
Now add a *UV Sphere*, enter *Edit Mode* and select a single vertex from the *top view* as shown. Use the "G" key to pull it out from the sphere. This will indicate the forward direction when we turn this into an actor and move it around with the arrow keys. Make sure that it is above and not touching the plane. This could cause it not to work when we turn it into an actor.

We now have a basic scene to work with. Add a *Material* to each object and change the *Diffuse* color for each so they stand out. You should have something like this scene.
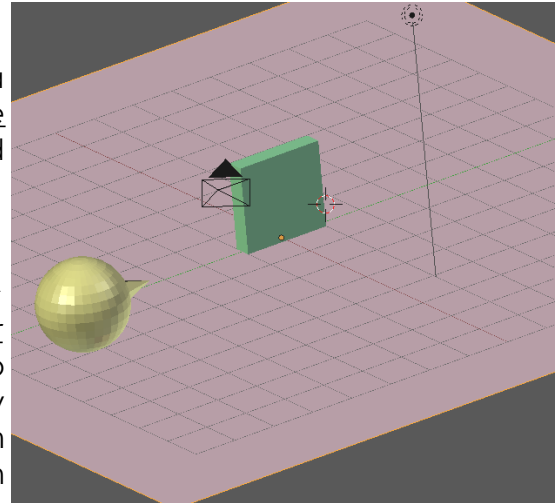
Setting the Actor:
It's now time to turn the Sphere into a *Dynamic Actor*. Start by setting the Engine from *Blender Renderer* to *Blender Game* (*page 22-1*). Go to the Physics panel and select "Dynamic" for they type. To keep the actor from sliding or spinning too much in the game, we'll set Translation Dampening up to 0.400 and Rotational Dampening up to 0.900. You may need to experiment with these later, but these settings should be good. If these settings are too low, you will notice that your actor "coasts" a lot after you take your finger off the key. This is also controllable in the materials settings with friction.

We shouldn't need to change the radius size since we didn't scale the sphere, but if you did, adjust the radius size to match, then hit "*Ctrl-A*" to reset scale and rotation settings.

It's now time to switch to the "*Game Logic*" screen layout so we can add some controllers.
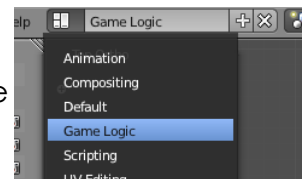
Game Terminology:

If you have worked with other game design software (we use *GameMaker Studio* for our 2D game design needs), you will start to see similarities between many of the programs. For example, *GameMaker* uses *Events* and *Actions* to control objects. An event can be something like a collision with another object or pressing a key on a keyboard or mouse. For every event, there can be many actions, like playing a sounds, moving in a direction, playing an animation, or shooting at something. As you work through Blender logic blocks, think of Blender *Sensors* like *Events*, and *Actuators* like *Actions*. This cross logic will help you see the common factors between programs.

Logic Block Construction:
Now that you've switched to the *Game Logic* screen layout, you will see the logic block window at the bottom. Think of this as an "Input-Process-Output" model, but called "Sensor-Controller-Actuator". You will also see a place to add a *Property*.


There are a lot of different types of sensors, controllers and actuators that you can use, more than we will discuss here. After you get a feel for working with this chapter, there are many discussions and examples on the internet addressing practical examples of all these. To get started, lets add a "***Keyboard***" sensor, a "***Add***" controller, and a "***Motion***" actuator.
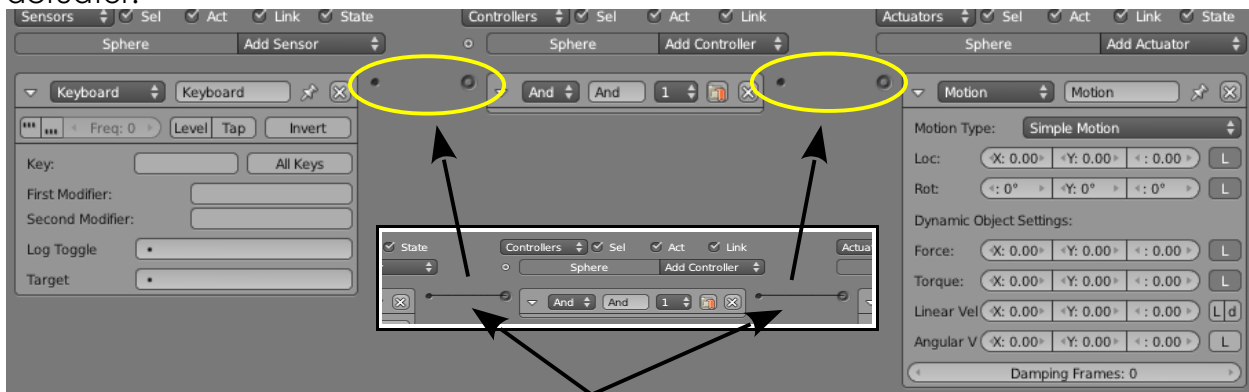

First thing, connect the blocks by dragging a line. To disconnect the, drag backwards.

The first thing we want to do is make the sphere move forward when we hit the Up arrow key. Click in the box by the word *Key*. It will say "*Press a key*". Hit the *Up* arrow key to assign it. There are other options, but we do not need them for this exercise.
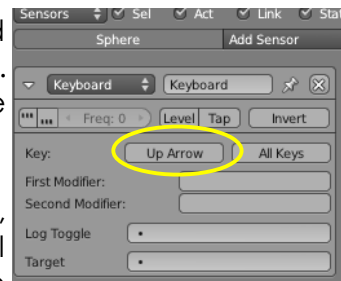

Think of the *Controller* as the computer processor. By default, we hit "*And*", meaning that if we tie more than 1 sensor to it, all sensors must be in a true state in order for an actuator to function. There are other expression available in the controller.

The Motion actuator works for dynamic and static objects. When moving a *Static* object, you will want to use the *Loc* and *Rot* motion outputs. You are setting a step movement or rotation. ***You probably do not want to use these for Dynamic actors!*** If you do, an actor might walk right through a wall. Think of this as real life. To move a *Dynamic* object, it needs a push (*Force*) or turning force (*Torque*). You will see columns for X,Y, and Z. **Let's set the Y Force to 5.00.** Hit "**P**" to test out your scene. Adjust the force if more or less is needed. If it goes the wrong direction, try a negative number or try the X column. Adjust actor *Dampening* to improve stopping.
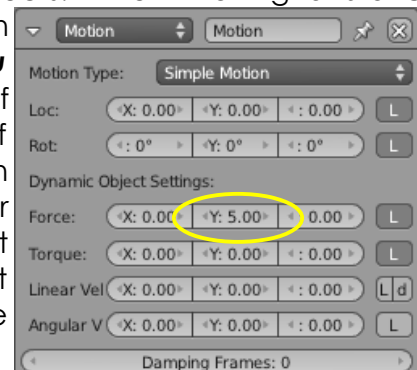
Now that you have the sphere moving forward, add more sensors, controllers and actuators to make it move backwards. In my case, all I would need to do is give it a Y force of -5.00 (*or any speed you wish*). To make it turn, you will need to apply a Torque in the Z column. **A Torque of 1.00 may be enough If not, try higher**. You should now have 4 directional keys for the sphere. *It's also a good idea to name your sensors. You may have a lot of them. You can also collapse them by clicking the small triangle.*
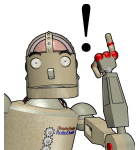
RoboDude Asks: Having trouble with the sphere rolling strangely when moving forward? Try going to the Materials panel and reducing the Friction of the sphere or floor (page 21-4). If your actor spins when it his the wall, also lower friction for the wall.
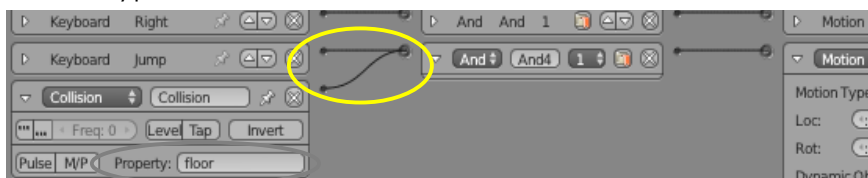
Your logic layout should look something like this:

Named Sensors

Collapsed Panels
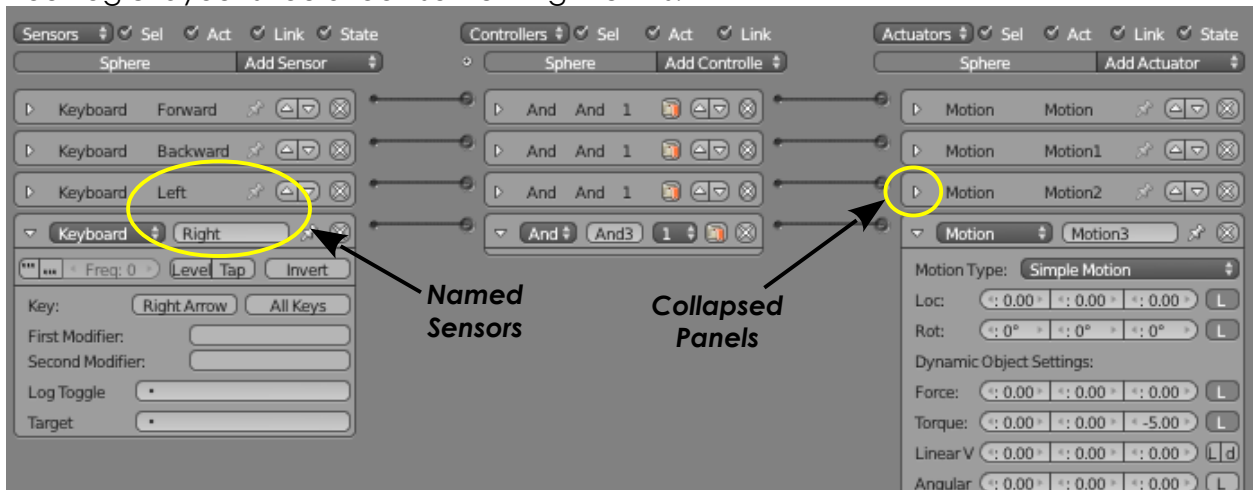
Let's add a **Jump** command using the *Space Bar*. Since you want him to jump and not fly, we will need to connect 2 *Sensors* to a *Controller* to make this work. One Keyboard sensor for the space bar and one Collision sensor with a named Property.
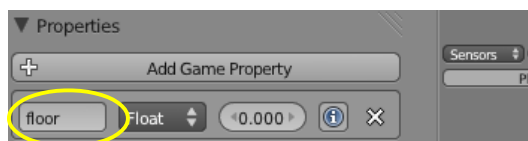
Select the Floor plane and add a Game Property (found to the left of the logic blocks). Give it a name called "floor". This is case sensitive.

Now go back and select the Sphere and add a Sensor-Controller-Actuator. Make the sensor a Keyboard and assign the Space Bar. Use an And controller and a Motion actuator. Give it a Force in the Z-direction of **100**. *Since the force will only be applied momentarily when in contact with the floor, it will need to be high in order to have a good jump.* Now, we need to add another Sensor and make it Collision. In the Property block, type "floor". Tie this sensor to the same controller as the keyboard for jump. Because it is an *And* controller, both sensor states must be true in order for the actor to jump. Adjust the force.

Using Animation in a Game:
Now that we have basic motion down, let's try an animation in the game. We will make the Cube act like a rising door when the actor gets close to it. We first need to add some animation keys to the cube. With the *Cube* selected and at *Frame 1*, hit "**I**" to insert a *Location* key. Move up to *Frame 60*, raise the cube high enough for the actor to pass under it and hit "**I**" again to insert another *Location* key. If it helps, change back to the *Animation* or *Default* screen layout during this step, then return to the *Game* screen.
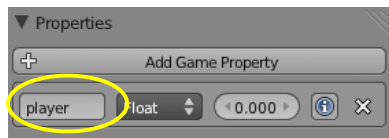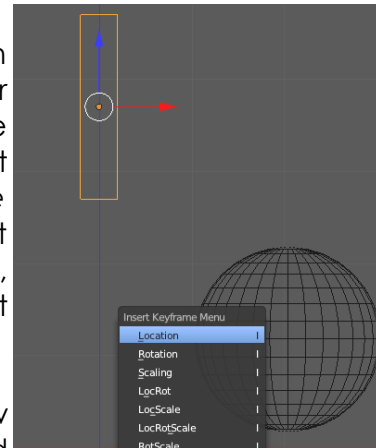
Back in the *Game* window layout, select the *Sphere* and give it a *Property*. Name it something like "*player*"

Select the *Cube* once more and add a *Sensor-Controller-Actuator* to it. This time, you will add a *Near* sensor, *And* controller, and an *Action* actuator. Set is up as shown:

Actor's Property Name

Flipper Action for Animation instead of Play
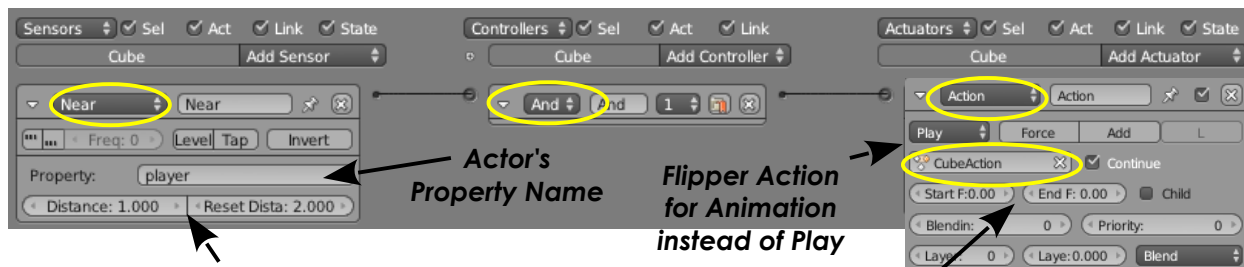
Distance-Reset:
Adjust for actor distance when trigger is activated. The reset distance (usually higher than distance) resets the trigger.
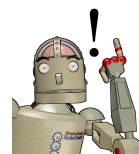
Start-End Frames:
Set these numbers to match the range of frames you wish to play during the action. Also add the "CubeAction".

When the actor with the property name "player" gets within the sensor's trigger distance, the actuator occurs. There are several different playing options in the *Action* actuator- *Play* plays the frames and stops; *Ping-Ping* plays frame forwards and backwards; *Flipper* plays forward, stops, then plays backwards during the trigger reset; and *Loop* occurs the entire time when activated.

These are just the basics of the Game Engine. With practice, experimentation, and a little research, you will be able to build some amazing games. Games are played through the *camera's view* so you will want to set the camera's location or child-parent it to the *Actor*. When you're ready to test the game outside of Blender, you need to enable exporting through the *User Preferences* in the *File* menu. Go to *Add-Ons* and select "*Game Engine:Save As Run time*". Now go to File-Export and save as a .exe file.

RoboDude Says: *When making a game, try to keep face counts on meshes as low as possible. The game must actively count and deal with the faces in a game. Detailed meshes will slow things down considerably. The best way to simulate detail is through detailed textures, which will be discussed in the next chapter.*

For this activity, your job is to design a maze full of motion. Create an actor that can be moved around with the arrow keys as discussed in the previous pages. To create the maze, start with a plane and scale it large enough to make a nice sized maze. Subdivide the plane as shown below, making sure the grid blocks are a little larger than your actor:
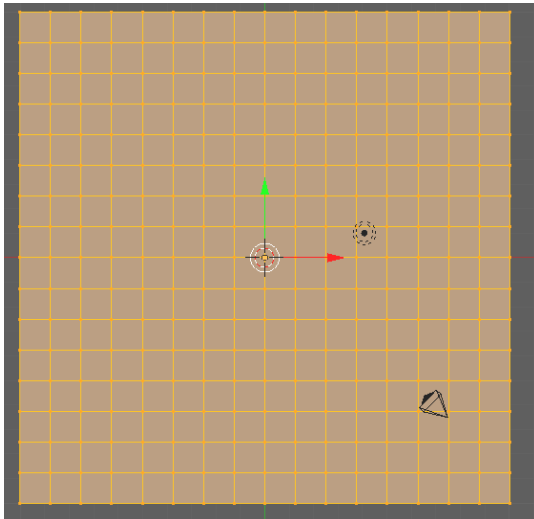
Switch from *Vertex* select to *Face* select in the lower bar and press "A" to deselect all faces.

Using the *Circle* selection method ("**C**" key), Select all of the faces you wish to use as walls.
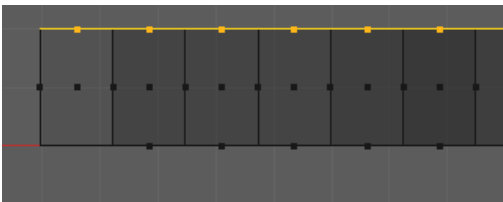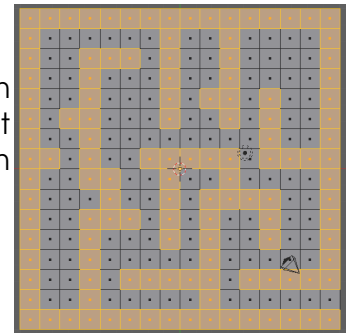
Now, switch to a **front view** and *Extrude* the walls up a few grid blocks. Switch to *Wireframe* view as well to help with the next selection.

Using *Box* selection ("**B**" key), select the walls from the front view, being careful not to window down too far to catch the floor. Press "**P**" to separate the *Selection*.
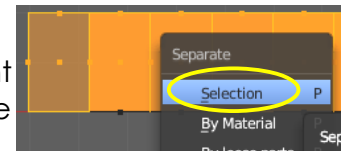
Add *Materials* to both the floor and walls, place your actor in a good starting location, *child-parent* the *Camera* to the *Actor* and place the camera directly above the actor for a first-person view of the maze.
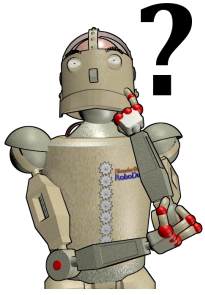
Challenge Task:

Add a door with animation that rises when the actor approaches it, steps, trap doors, etc. to make it interesting. *We will be discussing textures in the next chapter.*

** Call the instructor when finished **
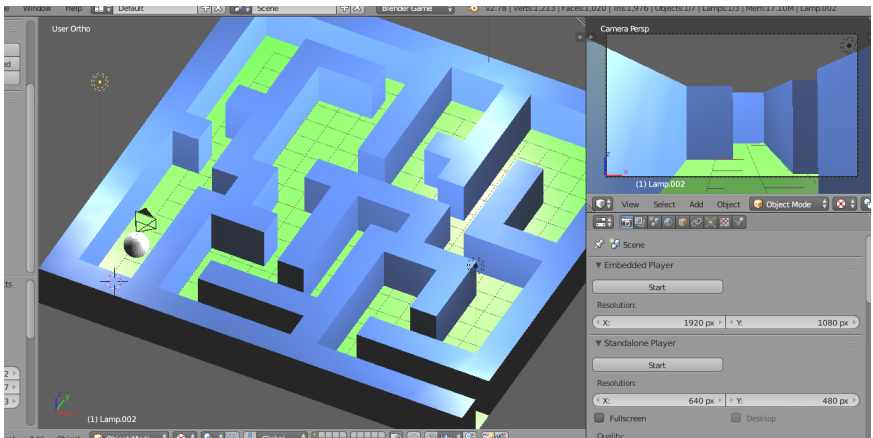
Chapter 22 Reflection and Wrap-up:

Real-Time Animation and Game Design

Not only can the game engine be used to make games, but imagine making interactive architectural designs where the client can move around the building in real-time to any place in the structure, or making virtual tours of famous historical places. Now imagine using your designs with a virtual reality headset or a simulator. Take a few moments to reflect on your learning.

1. **What did you find to be the most challenging aspect of this unit? Explain.**

2. **3D games lend themselves best to first-person style games. Now that you have experienced some of the basics of 3D game development, how has this experience changed your ideas of how 3D games are created? Explain.**

3. **Trying to find a balance between keeping the game running smoothly vs making the characters and scenes as detailed as possible is always a concern for game makers (*mesh detail, texturing, lighting, actions, etc.*) How do you think they find that balance? Feel free to research the topic of how to successfully design 3D games on the internet. What did you find out? Explain.**

4. **Explore the various sensors and actuators in the game engine and research how a few of them operate. What new and interesting features did you discover? Explain.**

Since games need to be able to process operations as fast as possible, traditional rendering techniques (*specular, ray tracing reflections and refractions*) cannot typically be processed fast enough for a game. For this reason, textures need to be mapped differently. There are also times when you may want to use mapped textures in an actual render. Blender does this through traditional *UV Texture Mapping* and a new system called *GLSL Shading*. There is a lot that can be done through both of these methods "beyond the basics" that will be discussed here. For more details, check out the Blender wiki.
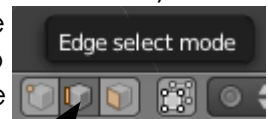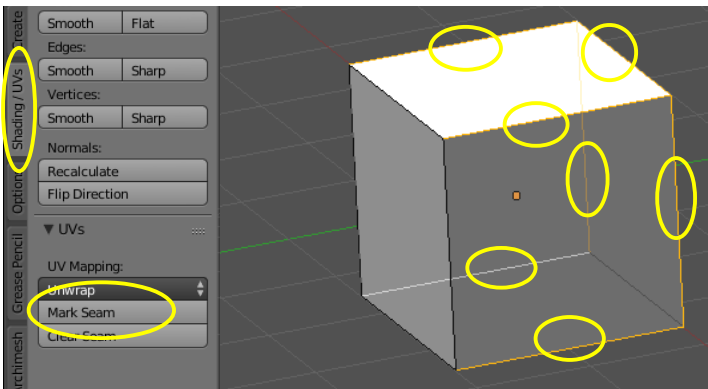
UV Texture Mapping

Think of *UV Mapping* like taking a box and cutting it to lay flat. The texture needs to match each side of the box. It is difficult to do that with traditional materials and textures. Let's say you want to model a dinosaur. The texture changes on various parts of his body and need to be mapped correctly. This is where UV Mapping come into play. For this example, I am going to map the following texture I made in GIMP on a basic cube:

This is just a jpeg image that would be impossible to map as a standard material/texture.
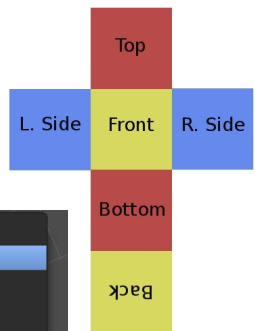
To begin, start with a basic scene with a cube and change your viewport shading type from *Solid* to *Textured*. This is the shading used during game play. You will notice that, by default, textures are effected by the lighting so add some lights to illuminate your scene better and switch to the "*UV Editing*" window layout. This will give you one 3D viewport and one UV Editor viewport. At the bottom of the UV Editor viewport, hit the *Image-Open Image* menu option and find the texture you wish to use.
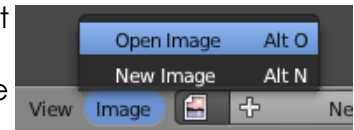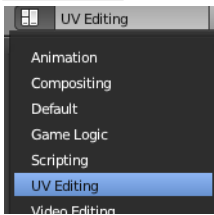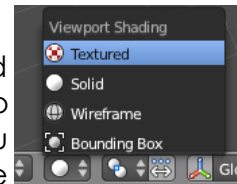
Now, enter Edit Mode for the cube and switch to selecting *Vertices* to *Faces* since this is a face applying process. You can select individual faces and put UV textures on that way, but let's "Unwrap" the cube to match our texture. This can be done for any mesh, but we need to mark the seams where we want a split to occur. If we look at the picture, we can see where seams should go. In order to mark seams, we need to switch from *Face* select to *Edge* select.

Select the following edges (*Shift-RMB*) and click "*Mark Seam*" in the Shading/*UVs tab* section in the *Tool Shelf*. These will be the unfold edges. It should match the box layout.

Chapter 23- UV Texture Mapping

Now go back to _Face_ select mode, hit "**A**" for _All_ twice to select all faces. Type "**U**" to bring up the _UV Mapping_ options in the 3D window. You have several option. We want "_Unwrap_". You will now see the unwrapped faces in the UV Mapping window. You can select these

vertices as you would for any other Blender object and move, scale or rotate them. You will also see the texture on the cube. By pressing "P" you will see the texture in game play. (_in object mode_) Adjust the vertices so it looks good on the cube.
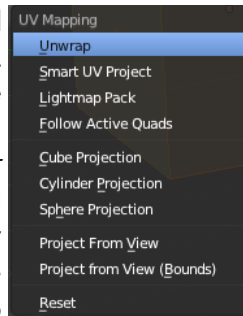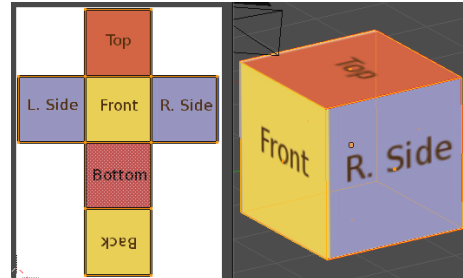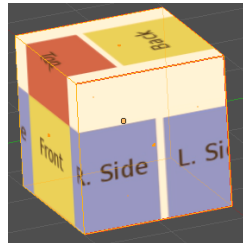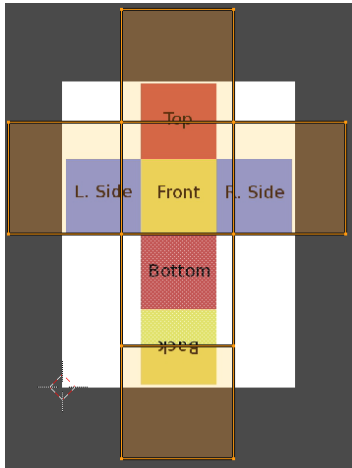
UV Textures in an Animated Movie:

Just like game physics can be written into an animation curve, UV can be used with materials and textures. After going through the steps above, add a material and texture to the object in the _Internal Renderer_.

Select "_Image or Movie_" for the texture type.

Select the picture you used in the _Image_ panel (it will be listed un the drop-down. You will not need to go out and open it from your folder again).

Under the "_Mapping_" panel, choose "_UV_" in the _Coordinate_ box. Pressing **F12** should give you a rendered image of the map.
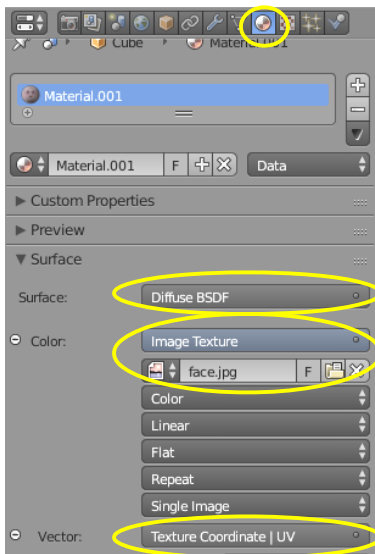
UV in Cycles:

This is the same as applying an image texture as discussed before with only a few adjustments. After creating the unwrapped UV map, go to Cycles Materials panel, use a _Diffuse_ node, set _Color_ to _Image Texture_, Select the image from the drop down option, and set _Vector_ to _UV_.

GLSL Shading

GLSL shading is relatively new to Blender and is an area seeing a great deal of development. It is an attempt to add many rendering-like features to the game engine, adding to a more realistic environment. As with the UV Mapping section, this unit will only cover the basics to get you started.

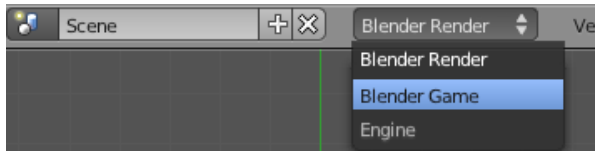*Not all video cards are supported for GLSL shading. Some machines will be unable it use this feature. See the Blender wiki for current specification.*

To get started, we'll start a new scene and split the viewport, setting one to *UV/Image Editor*. Set the Engine to "*Blender Game*" and viewport shading to "*Textured*". The last thing you need to do is switch from "*Multitexture*" to "*GLSL*" shading in the Render panel. You are now ready to work with the GLSL features in the game engine. Not all texture and shading features are available in GLSL, but many are and others are being developed constantly. As mentioned before, we will only be looking at some of these features.
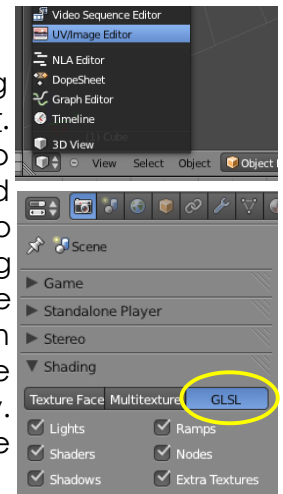
Adding Textures:

Basically, to add textures for the game in GLSL, you need to add materials and textures the way you do for any movie in the internal render engine. For my example, I am working with a plane for the ground and a cube. I've added a material and texture to the floor, using a stone texture. The stones are too large so I need to repeat it a bit in the texture panel. You can't use the X and Y Repeat in the "*Image Sampling*" panel, but can change the size in the "*Mapping*" panel.
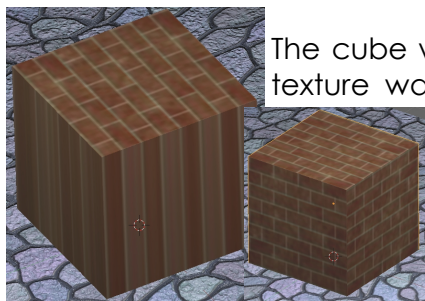
The cube was a bit more difficult. Because the texture wants to map as *Flat* by default and GLSL does not currently work with changing the mapping to *Cube*, I had to apply the texture as we did in the previous section using *UV Texture Mapping* and mapping the texture to each face. Remember to also switch the *Mapping* in the *Textures* panel to *UV*.
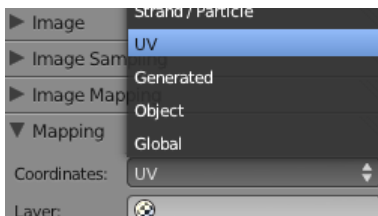
Another nice feature with GLSL is the ability to show *Normal Geometry* to give a texture depth. Looks best with a higher *Specular*.
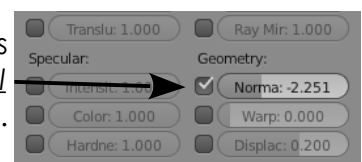
Shadows in GLSL:

Another nice effect allowed in GLSL is the ability to cast _shadows_ in game play. Right now, ray tracing is not supported so your only option is to use a _Spotlight_ with a _Buffer Shadow_ setting (_refer to the lighting chapter for more details on setting the buffer shadow_).
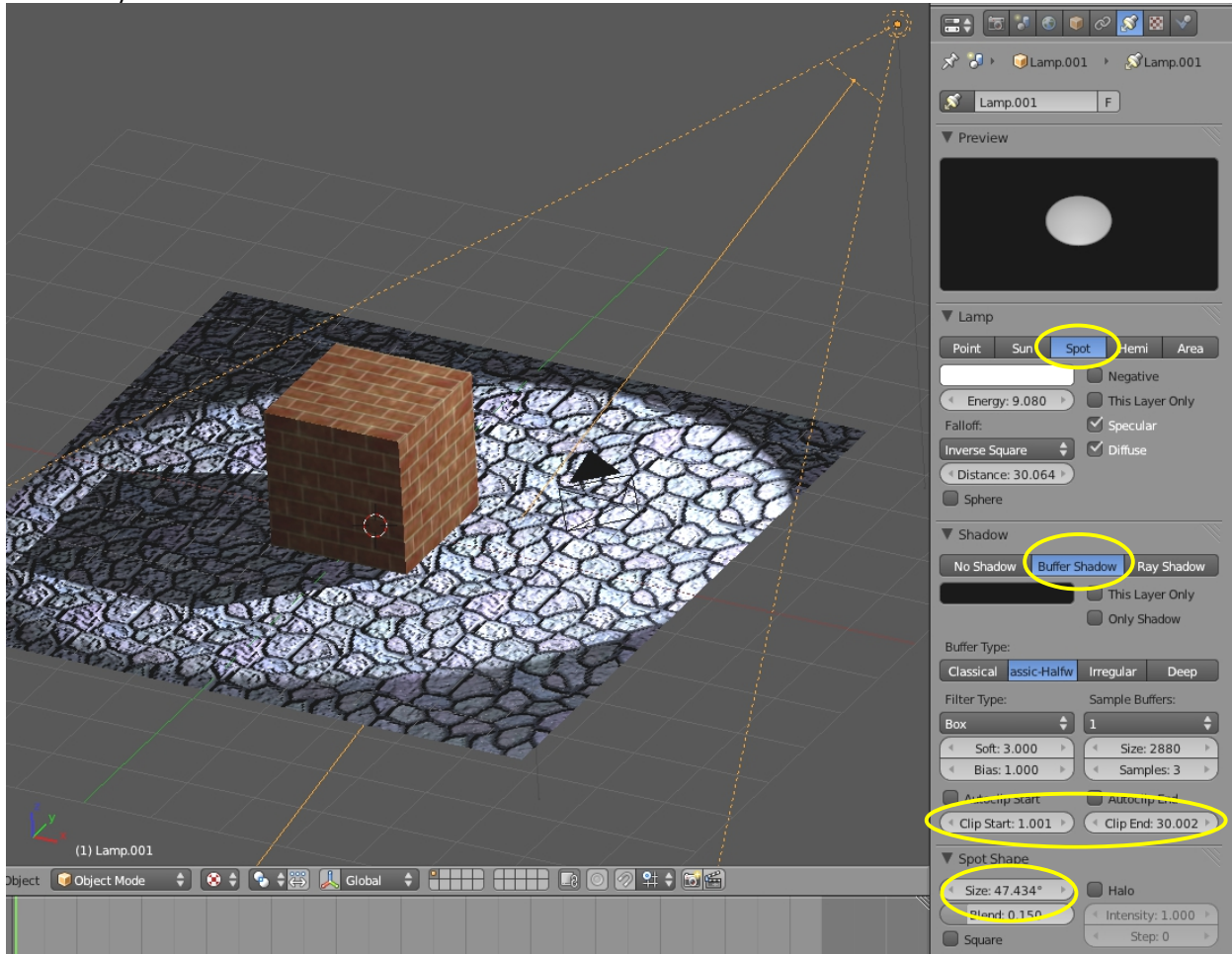
Currently, there is a lot of development in GLSL with new features constantly being added. There is also a lot of work in _Baking_ settings to improve performance. There is work on support for indirect lighting, fluids, soft bodies and many more. For up-to-date information, follow the Blender wiki, YouTube, and the forums.

World Settings:

While some _World_ settings work in _Multi-texture_ mode and some work on _GLSL Shading_, Some features do not work in either at the time (_stars for example_). In Multi-texture shading, you can get a nice effect with the _Mist_ settings to give a "foggy" feel to your game, but works a bit differently in GLSL. World Horizon and Zenith colors work differently as well.
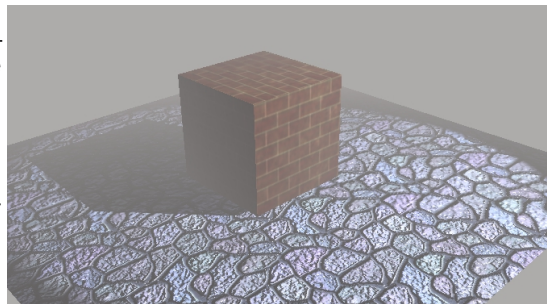
Scenario:

You work for an advertising firm and have been asked to create a commercial featuring your client's new cereal brand. Create a table scene featuring the product.

Using the UV texture mapping features, create your scene. Search the internet for an unwrapped box pattern of your favorite cereal to use or scan your own box. Here is the texture used in this example:

Create your box from a cube, apply the UV texture maps, and add other elements to your scene.
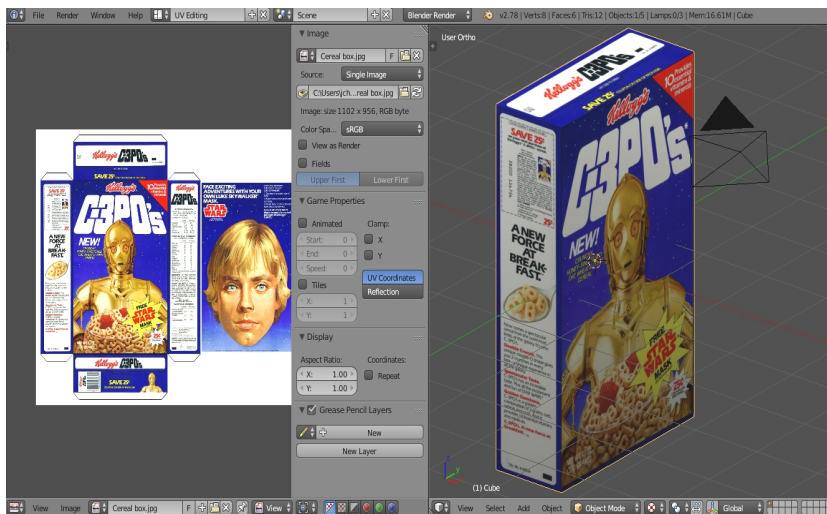
Rather than trying to unwrap the entire box, try selecting a single face to unwrap using the "**U**" command in edit mode. You will have a single face with corner vertices in the image mapping window to work with. Move those points around to match the side you want to use. You may also need to rotate the face. Continue until finished.

Add other elements to your scene to make it look nice and realistic. Add appropriate lighting and set a good camera angle. Render and save an image of your work.

** Call the instructor when finished **

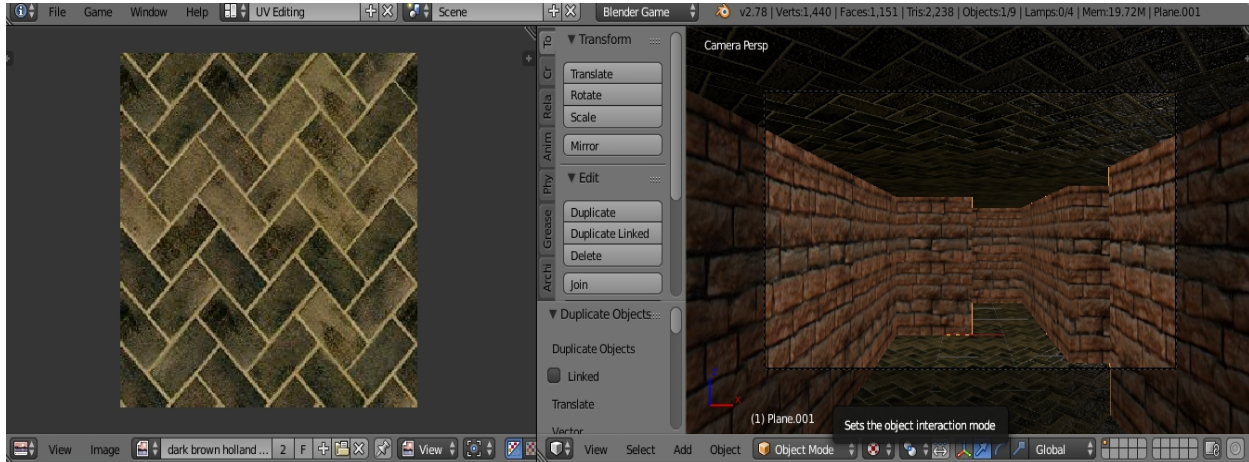For your challenge task, open your maze game file. Add appropriate UV textures to the elements in your game. Add a world that uses mist in your maze for a dreary effect. Feel free to add and texture any other elements you wish.

*** Call the instructor when finished ***
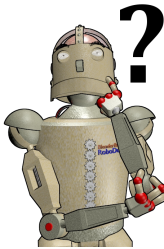
? Chapter 23 Reflection and Wrap-up:

UV Texture Mapping

UV maps are used in most professional movies and advertisements. Please take a few moments to reflect on these questions.

1. **Take a look at a 3D animated animal (bird, dinosaur, etc.). Look at the variations in the texture of the animal. Why would it be difficult to get a texture to map correctly using the traditional image texturing in Cycles and the internal render engines discussed earlier in the book? Why would UV mapping be better? Explain.**

2. **Research the internet for how you would unwrap an animal, like a dinosaur, and UV texture it in Blender. What did you find? Explain the process.**

We've come to the second to the last chapter of the book (*the last chapter deals with 3D printing*) and what better way to end this introduction to Blender than to compile all of your work into a final movie. While you can compile your video in programs like Adobe Premiere or Windows Movie Maker, Blender has it's own movie editor that is quite functional. Combine the *Video Editor* with *Nodes* and you have everything you need to make a professionally edited movie with sound, right inside Blender.

Compiling Your Clips and Images

Think of all the work you've done in Blender. You probably have a lot of short movie clips and saved images. Let's put them into a movie. Most movies start with a black screen. To handle this, I typically insert a picture that has been saved as just a black filled image.

First thing, set up your scene for your final movie output. Blender can only compile sounds into an MPEG movie (*due to open source issues*). This is actually great because mpeg2 movies output high quality and are DVD-ready. The settings are just a review of what we have done in previous chapters. *If you need a review, look at page 7-3*.

The only thing new is that you need to make sure the "*Sequencer*" box is checked in *Post Processing*. Without this being checked when you hit "*Animate*" Blender will only animate the 3D scene and not the sequence. *For best results, always animate at the same size and frame rate- mismatched sizes and rate could cause output problems.*
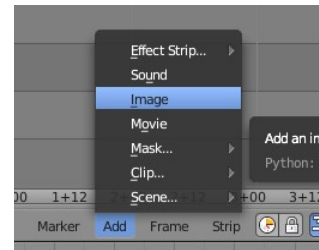
Now, switch the screen layout to "*Video Editing*".

Here is a look at the screen layout:
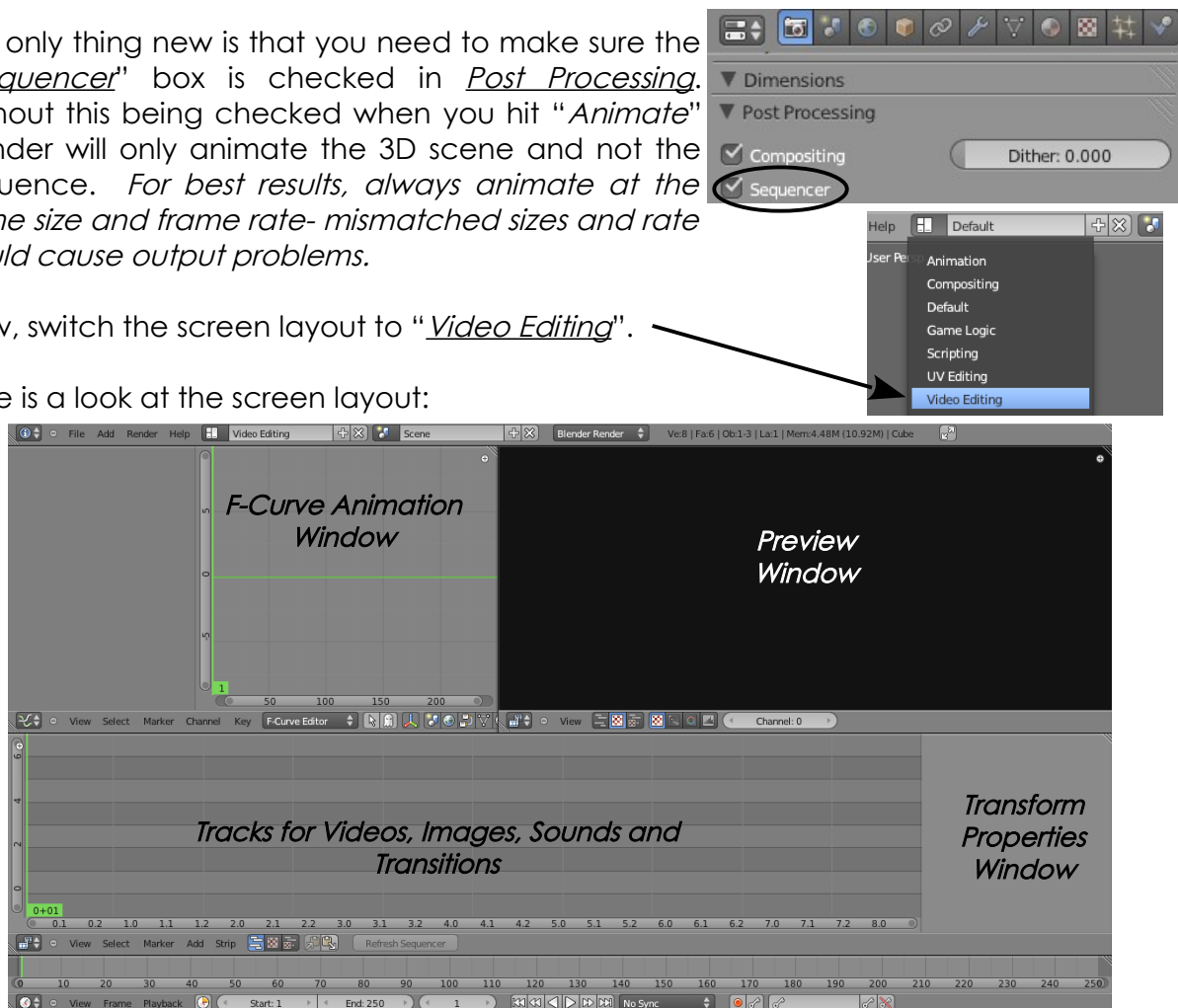
Let's start by adding 2 images to our time line. We'll add a _Black_ screen image and a saved image of out _Lighthouse_. To do this, click the "_Add_" button at the bottom of the window and select the "_Image_" option. You can add Effects, Sounds, Images, Movies and Scenes. Browse to your saved images. My 1st image will be a black screen. It doesn't matter which track you drop it into, but I usually work with the bottom tracks for images and movies. Place the track to start at _Frame 1_. Items placed in the time line can be selected and moved using standard Blender commands (_G key_). You can also zoom and pan in the tracks. By default, my image came in only 25 frames long- not even a second. This is where you need to get a feel for how long an image should be displayed. I want my black screen to last for 2 seconds plus 1 second for the fade transition. _This would be a total of 3 seconds, or 90 frames._ To lengthen an image, _RMB_ click on the end of the strip. Only the end frame of the strip will highlight and you can stretch it with the "**G**" key. You will also notice that the numbers along the bottom of the window represent seconds. _Only images can be stretched, videos cannot. They will give the appearance of being lengthened, but only the first or last frame will show longer._
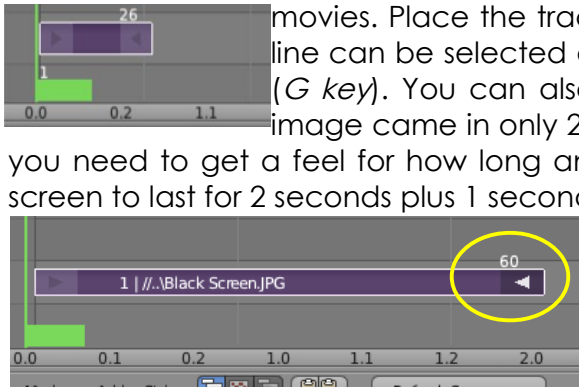
It's now time to add the second image. Go to the "_Add_" button again and find the next _Image_. Place it on the track above the first one and overlap it about 1 second for the transition.
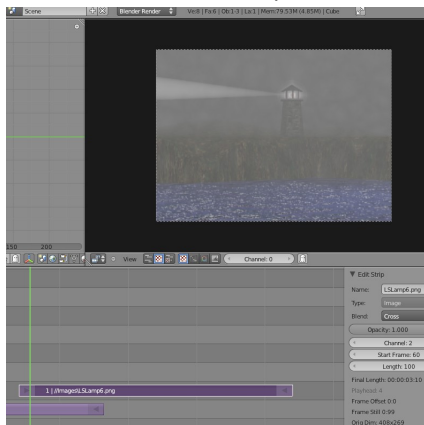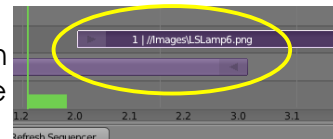
If you grab the green bar on the time line tracks (_represents current frame_) you can drag it with the **LMB** as you watch the _Preview Window_. You can scroll the mouse wheel in the Preview Window if you need to zoom in or out. You should notice a switch from black screen to the rendered lighthouse. Right now, it is an abrupt change. We want a smooth cross fade.

To add a _Cross Fade_, you need to select _Both_ tracks that you wish to cross with the **LMB** while holding "_Shift_" (_standard Blender multiple selection command_) _It is important that you select the image that appears first in time (black image), then the second. Otherwise, the cross will work backwards._ With both selected, go to the "_Add_" menu, "_Effect Strip_" and choose "_Cross_". Place it in the track above the two. There are many options for different effects.
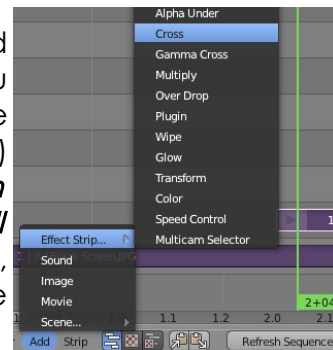
Now when you scrub the time line with your mouse or press the play button (or "Alt-A"), you should see a smooth transition.

More About Transitions:

While many other video editors give you more transition options than Blender (*star bursts, spirals, etc.*), Blender has what most people need for professional production. **A Cross or Wipe**. When you watch a movie, most scene usually just cut from one clip to another or fade (cross) to the next scene. Sometimes, you will see a wipe or iris effect, which Blender can do. If you add a "Wipe" from the "Effects Strip" menu, you can scroll down through the Transform Properties window on the right to see your options. The current options are:
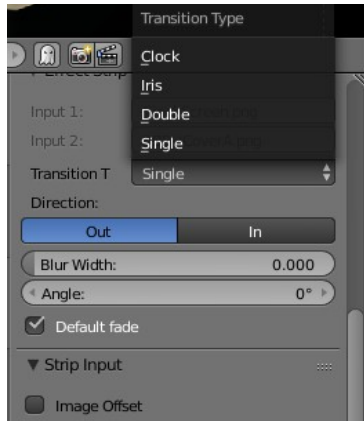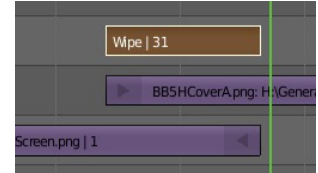
Transition Type: Select Clock, Iris, Double, or Single to show the type of transition effect.

Direction: Controls the direction of effect (up/down, left/right, in/out, clockwise/counter-clockwise).

Blur Width: Does the effect have a sharp edge or blurred?

*Angle:*   Horizontal, vertical, or other angle of wipe.

Adding Movies:

Now it's time to add a movie. Follow the same steps as before, but select "*Movie*" from the "*Add*" menu. When the movie come into your tracks, it will also contain an *Audio* track, represented in green (*even if your video contains no audio*). You can delete this upper track if desired. Place the movie and add a transition as before.
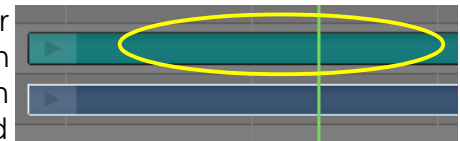
"K" Knife Cut

If you need to shorten a movie track, you can select the end and shorten it, like we did to lengthen an image, or you can place the green "current frame" bar at the desired cut location, select the clip and hit "K" for **knife cut**. The movie is split at that point.
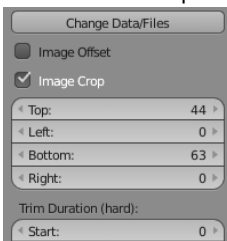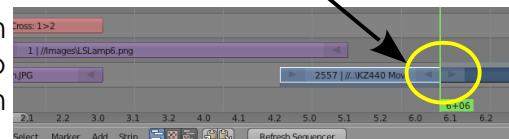
When taking videos with phones and cameras, it may be difficult to keep your image sizes the same. Meaning, when they are brought into the video editor, they may be stretched to fit the Blender output dimensions. To correct this problem, images and movies can be cropped in the Transform Properties window by checking the "Image Crop" box. Simple adjust as needed.
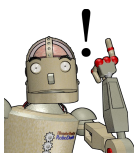
RoboDude Says: It is best to work with movie files that have all been rendered at the same size and frames-per-second. Problems may occur when Blender tries to convert files that are different from the output you have selected.

More about Effect Strips:

So far, we've used the most common type of effects- a *Cross and Wipe*. Blender has several other useful effects in the Effects Strip menu. Here are a few:

Alpha Over/Under: If you have an image or image strip that has a transparency channel, like a title overlay, you an use these effects to do composite work. Just place the image over the movie strip, select both tracks, then add an "*Alpha Over or Under*" effect to combine them. The example to the right shows a text image with transparency placed over another image.

Text:
New to Blender is the "*Text*" effect strip. This will allow you to add simple text overlays on your time line without having to create them in another graphics program, like GIMP. Options are limit at the time of this writing, but I expect the text command will grow in future releases. Currently, you cannot change the font and animating effects (i.e. changing the size or location of the text over time) are rough, but there are many other settings. You can change position and alignment, size, and add a shadow. You can also add Strip modifiers in the Transform Properties window to change brightness, color, and contrast.

Speed Control:
If you place a movie into your sequence that runs too fast or too slow, you can select that movie and add a "Speed Control" effect strip to the movie to change the speed. Select the end of the movie after adding the Speed Control and simple move it. The movie will stretch or shrink.

Finishing Your Video Tracks:
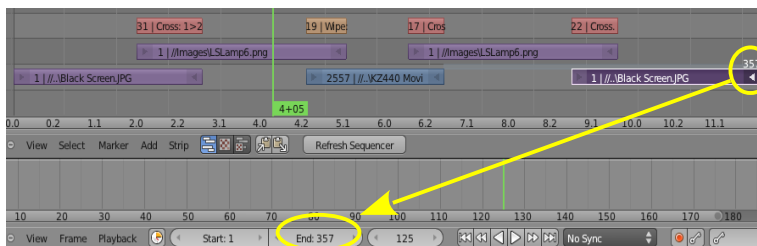
Continue to add images, clips, and transitions to finish the video part of your project. Sticking to the bottom tracks keeps your project looking clean. I usually alternate between 2-3 tracks. *Don't forget to match your End frame to the end of your movie.*

RoboDude Asks: When I press the "Play" button or press "Alt-A", why doesn't my movie play through? *Check the End Frame of your movie- you probably need to adjust it.*
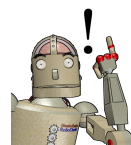
Adding an Audio Track

Adding an audio track isn't much different from adding images and movies. Many different audio track formats are accepted by Blender and the most common are WAV and MP3 files. Some files may need to be converted through an audio converter, many free on the internet. There have been some helpful upgrades to working with audio in the sequence editor. To add an audio file, go to the "*Add*" menu and select "*Sound*".

Find your file and add it to an upper track. Trimming an audio track is accomplished the same way you cut or shorten a movie or image. (*grabbing the end or using the "K" knife tool*). To help you find a more exact point, you can zoom in on the audio track and see the waveform after checking the "*Draw Waveform*" box in the Transform Properties.
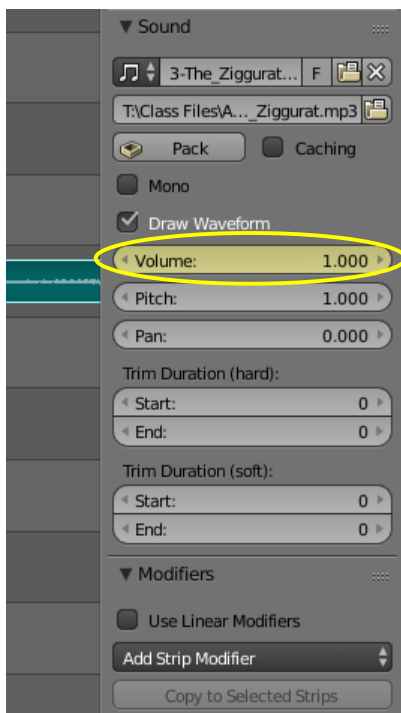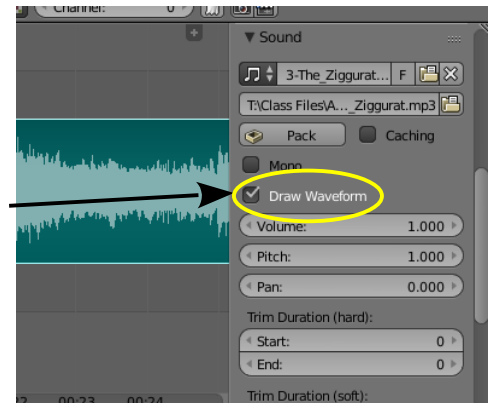
With an audio track selected, look at the options to the right. The most important options are displayed at the bottom. You can "Pack" a sound into the Blender file and adjust it's *Volume, Pitch,* iand *Pan* and if it is too loud or soft.

Need to fade a song in or out? Need to to cross fade from one song to another? Remember that Blender can animate any block. This means that you can animate the volume. Go to a frame where you want to start a fade out, place your cursor over the "*Volume*" block and hit "I" to insert a key, them move up in time, set the volume to *zero* and hit "I" again over the block. You now have a fade out.
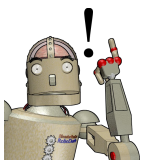
> *RoboDude Asks: When I press the "Play" button or press "Alt-A", why doesn't my movie play at a consistent speed? It is difficult to run everything properly on the screen. Transitions need to be calculated and audio added. You could try going into "User Preferences" and the "System" tab to try to increase sequencer memory. When you crunch the movie, it will play real-time.*

After you have the video completed, it is time to animate the sequence exactly like you would for any other movie made in Blender. You may need to return to the "Default" screen layout and set your render output file name/location. Finish by pressing the "*Animation*" Button.
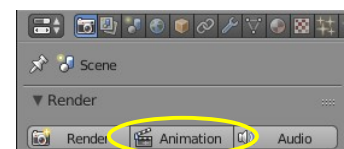
Produce a Movie

This is a great exercise to end the book with. Your job is to take all of the images and movies you have created through these exercises and produce a compiled movie. I recommend making a *Black JPEG image* to use for your **first** a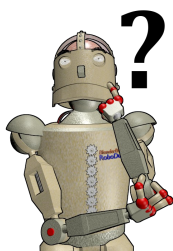nd **last** image (*start and end in black*). Images should be displayed for approx. 3-5 seconds with 1 second transitions. When finished, go back to the _Default_ screen and hit "_Animate_".
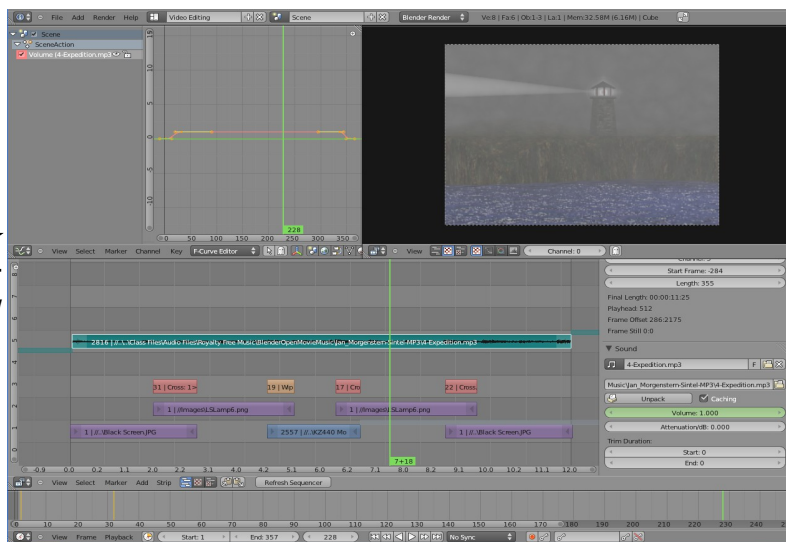
*** Call the instructor when finished ***

 ? Chapter 24 Reflection and Wrap-up:

Program Interfaces and User Reactions

You have just scratch the surface of what Blender can do and the possibilities are limitless. The internet is a great place to find answers.

1. How pleased are you with the results of your final movie? What would you do differently?

2. Out of all of the activities you did in Blender, what was your favorite and why?

3. Which activity was your least favorite and why?

4. Has this experience shaped your thoughts on any future career options? Explain your answer.

5. Do you still look at movies that use animation in them the same way you did before your Blender experience? Explain your answer.

3D printing (*also called rapid prototyping*) has become a hot topic in recent years. They are great tools to bring your 3D designs into the real world and Blender can be a great tool to use to design those ideas. There are many different 3D printing processes, but the most common, and cheapest, system deposits thin layers of plastic onto a table. Layers are typically around .25mm high with extruders squeezing plastic out of a hole that is around .4mm in diameter. 3D printers were once very expensive, but have come down in price in recent years where you can now buy good quality kits for as low as $250-$350 that give you a nice build size. The *RepRap.org* movement is responsible for bringing the costs down with a variety of printer designs through their open-source movement. If you are interested in building your own 3D printer, on the same site as the *Blender Basics Book*, you will see a page dedicated to "**3D Printing Resources**" where I have pulled together resources from my own experiences. I would also recommend visiting www.reprap.org for all things open-source 3D printing.
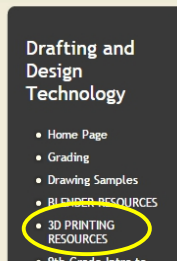
Fundamentals of 3D Printing

When designing 3D models for printing, there are several factors that must be considered for successful results. You need to be aware of the build size limits of your machine, units you wish to work with, building with or without supports, and making sure the mesh is closed with no errors in the geometry. The process for 3D printing is as follows:

3D Printing Process

| 3D Cad Model | .STL File | Slicing Software | Layer Slices & Tool Path | 3D Printer | 3D Object |
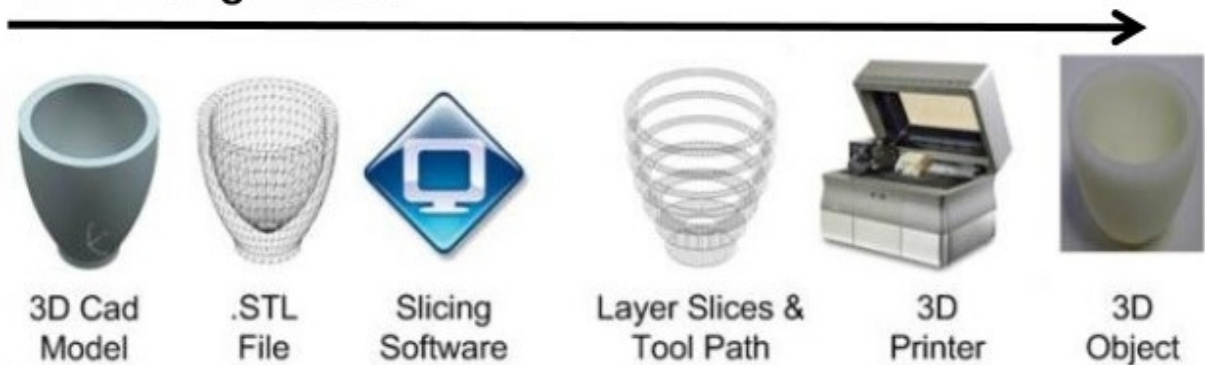
1. **Design your project** in your favorite 3D modeling program (Blender, SolidWorks, etc.)
2. **Convert the file to a .STL format.** STL files are generic 3D model files used by many programs.
3. **Slice the file in a popular slicing program.** Creates the individual layers for the printer.
4. **Create the G-Code** file in the slicing program for the 3D printer to read.
5. **Print the part in your 3D printer.** The process usually takes hours, depending on your machine and part details.

Using Blender to Create 3D Printer Models
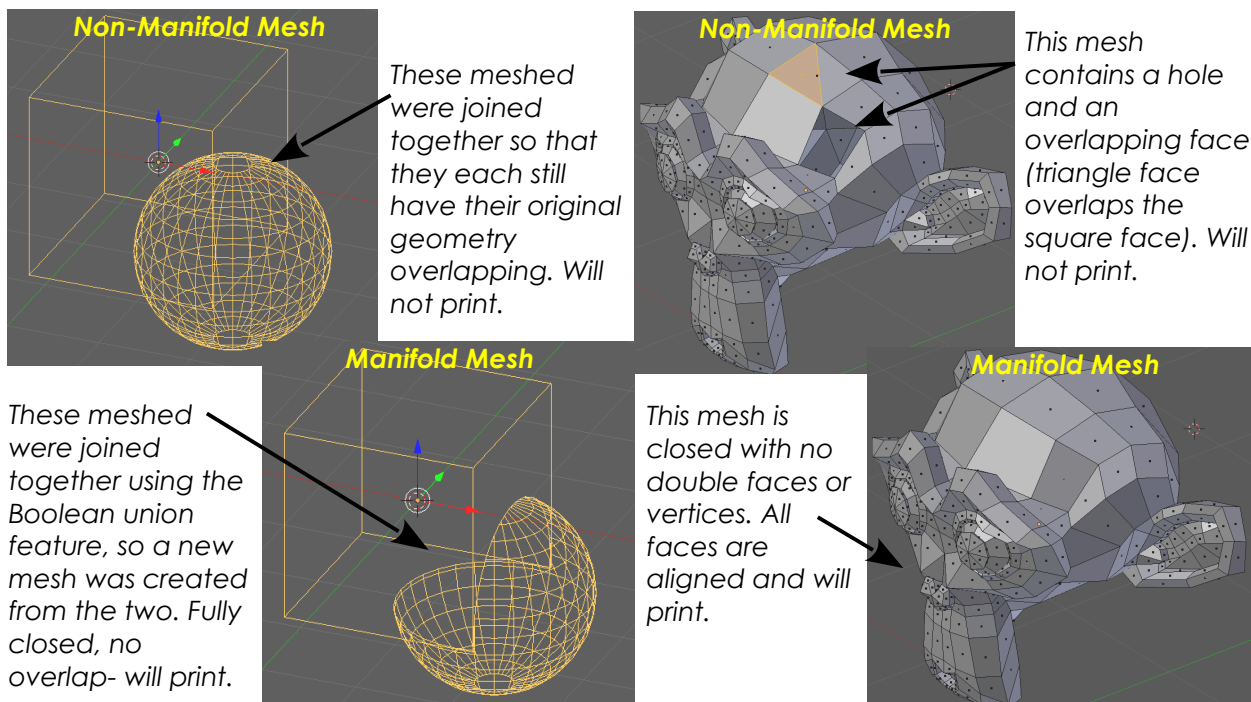
Almost any 3D design software can be used to create models for printing with Blender being one of those tools. Blender is not the easiest program for designing models, but with a little practice you can create just about anything. Programs like SolidWorks and Inventor are easier because, as feature are added to the model, they are automatically joined to the mesh, unlike Blender where you need to manually do all the Boolean operations to join features. Also, measurement systems in Blender can prove to be more of a challenge.
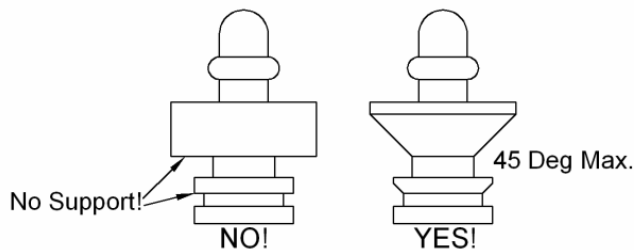
Remember that 3D printers work like hot glue guns, only more precise and a lot hotter. Molten plastic cannot suspend in the air and needs some form of partial support under each layer. Look at the picture to the left for an example. While angles greater than 45 degrees can be achieved, keeping them at 45 degrees or lesser will prove more successful.

The Manifold Mesh

One of the biggest problems that you will encounter with Blender more than in a traditional CAD program is the **non-manifold mesh**. Basically, a non-manifold mesh is a mesh that couldn't possibly exist in real life because of mistakes in geometry. There could be holes where faces should be, or flipped faces, or double vertices, or overlapping faces. Most Slicing programs will try to fix these, but sometimes the problems are too bad to be fixed automatically. The best solution is to make a **manifold** mesh from the beginning so things go well from start to finish.

Non-Manifold Mesh

These meshed were joined together so that they each still have their original geometry overlapping. Will not print.

Non-Manifold Mesh

This mesh contains a hole and an overlapping face (triangle face overlaps the square face). Will not print.

Manifold Mesh

These meshed were joined together using the Boolean union feature, so a new mesh was created from the two. Fully closed, no overlap- will print.

Manifold Mesh

This mesh is closed with no double faces or vertices. All faces are aligned and will print.

Tools for Modeling

Blender has many tools to help you create the perfect model for 3D printing. The first consideration is scaling and dimensioning. If you stick with proportion around the initial Blender cube, your model will be about 2mm x 2mm x 2mm. That's a pretty small model.

In order to work with acceptable measurements, you will need to open the numeric side panel on your screen (the "**N**" key). When creating objects, pay close attention to the "*Dimensions*" panel. These numbers represent *millimeters*. While most slicing programs will allow you to scale your model, it is best to work in real units as much as possible.
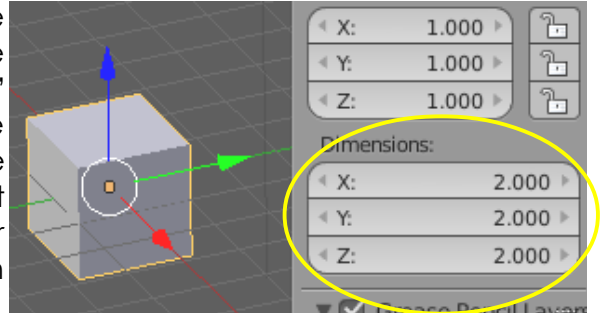
Since you are now experts in using Blender after working through this book, you should know these basic tools to help keep your model neat and clean:

- *Extrude command (3-6)*
- *Remove Doubles (3-10)*
- *Recalculating/Flipping Normals (3-8)*
- *Boolean Modifier (3-18)*
- *Adding Faces(3-17)*
- *Spin Tool (revolved shapes) (20-4)*

*RoboDude Asks: **What do I do if I want to cut a hole through a block?***
To keep your mesh manifold, the best option would be to make a cylinder that represents the hole, place it in your mesh in the correct location, then use a Boolean modifier to subtract the cylinder from the mesh.
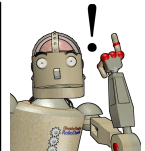

Working to keep your meshes manifold can be difficult at first, but as you become a Blender Ninja, this will become easier.

Exporting Models

After you have completed your model and ready to take it out of Blender to your slicing program, there are a few more tools in Blender you will want to use. Blender now has an add-on called **3D Print Toolbox** that is full of useful tools to make sure your mesh is good for printing and exporting. To enable the 3D Print Toolbox, go to "*File*" and "*User Preferences*". In the "*Add-ons*" menu, find the "*Mesh: 3D Print Toolbox*" option and enable it. You will now see a tab called "*3D Printing*" at the bottom of your other tool shelf tabs on the left.
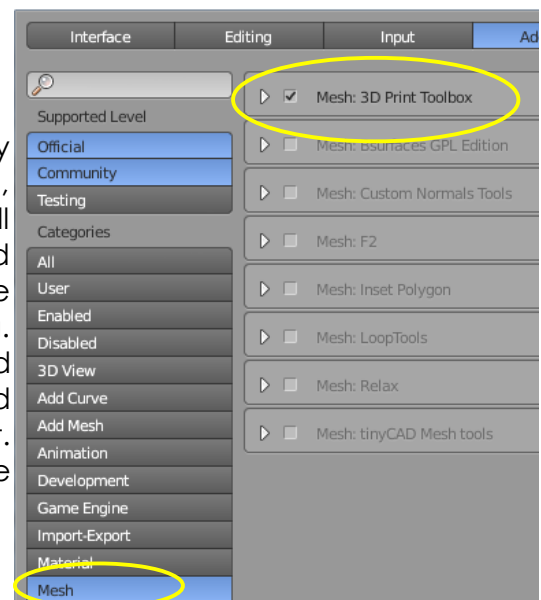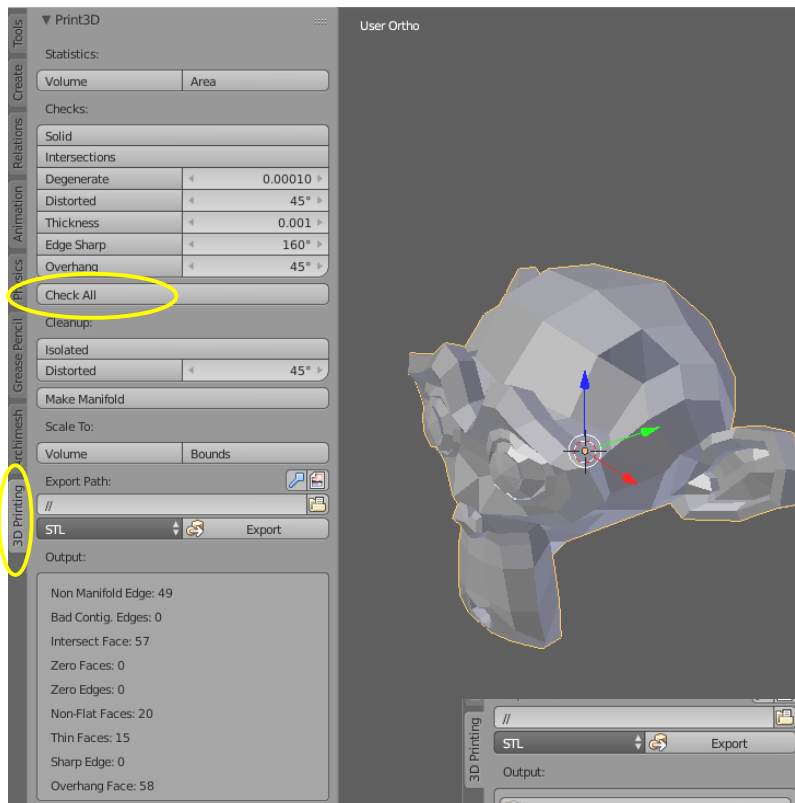
With the mesh selected, you will see your tool options in the **3D Printing** tool shelf tab. In this example, we are using the monkey head that has a lot of problems. You will notice all of the different errors that can be detected in the panel and their settings. For example, most 3D printing recommends that overhangs be kept under 45 degrees, but many times that can be set to a higher angle and still work. The "*Check All*" button will detect any problems and list them at the bottom of the panel.

If you go into Edit Mode, the errors will turn into buttons that will highlight on the mesh for you so you can fix them.
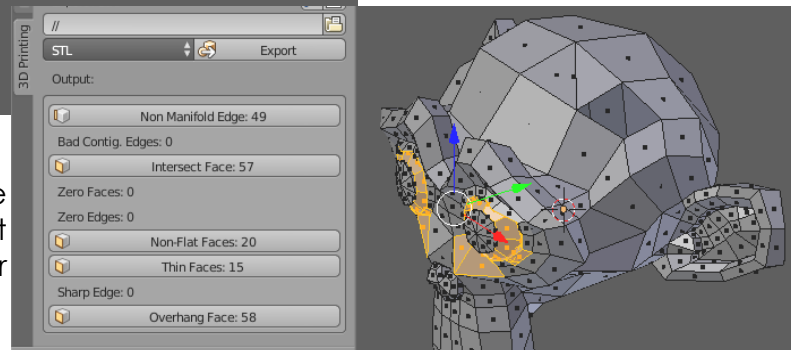
If you have a 3D printer with multiple extruder heads, or the ability to print in multiple colors, The export feature in the 3D Printing tab can work well for that. When designing a 3D model for printing that has several parts assembled for different colors (i.e. a name plaque that uses one color part for the main part and another color part for the letters), the parts need to be exported as .STL files that remember their exact locations in the assembled models. To use the Export Path option in the tool shelf, follow these steps:
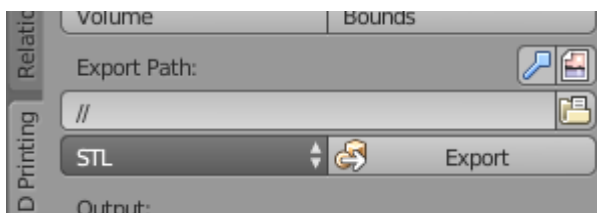
Set the *Export Path* to your saving location.

Select the *Output* file type (*typically .STL*).

Select a mesh and hit *Export*. The part should export to your saving location with the file and part name. Repeat the process for each part of the assembly. You are now ready to take your files to your slicing program. We use Slic3r in our lab which is free and easy to use. For more information about Slic3r, go to www.slic3r.org

For this simple activity, create a simple chess piece that could be 3D printed if you have a printer available. The part could be a simple revolved or extruded pawn or something more elaborate, like a rook, bishop, king, or queen. Want a bigger challenge?- design a knight! If you have the time and the printer, why not make an entire chess set?
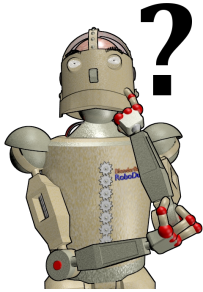
Pay close attention to the problems mentioned in the chapter. Your goal is to be able to run your model through the *3D Printing* tool shelf checks and come back with zero errors in all categories (*There may be some acceptable results, look for the bad ones*).

When finished, export the part as an .STL file.

** Call the instructor when finished **

PERFORMANCE TASKS

Chapter 25 Reflection and Wrap-up:

3D Printing Design

3D printing has a bright future where they may become as popular as paper printers are at home. Take a few moments to reflect on the unit.

1. Research **www.reprap.org** to learn more about the open source printer movement. There have been many printer designs released through RepRap. Which printers have you see in media or operation? If you were to build one for yourself, which design would you choose and why? Explain.

2. Now that you have selected a possible 3D printer design, research the internet to see if the printer is available as a kit. Popular sites to search are Ebay and Amazon. What did you find? Are they expensive? Search for instructional pdf files or YouTube videos for assembling the printer. Do they look hard to assemble? Explain.

3. Research another type of 3D printing other than extruded plastic systems. What is another type of 3D printing that has a bright future (you may find several) and why do you think it has promise? Explain.

Academic Standards:

As educators, we need to evaluate the lessons we teach to make sure they align to some form of accepted educational standards. This Blender manual is no different. Your Blender lessons can tie together mathematical, technical, scientific, and communication skills as the students learn the basics of 3D modeling and animation. They can also work well in a STEM (Science, Technology, Engineering, and Mathematics) curriculum. In an effort to demonstrate the many educational standards that are addressed through these lessons, these charts have been developed using the following federally accepted standards:

- NSES Science Content Standards
- NCTE Standards for the English Language Arts
- ITEEA Standards for Technological Literacy
- NCTM Standards and Expectations

These standard alignments can be found on the following pages.

National Science Education Standards Grades 6-8
Students will develop an understanding of:
UNIFYING CONCEPTS AND PROCESSES
Systems, order, and organization
Evidence, models, and explanation
Change, constancy, and measurement
Form and function
SCIENCE AS INQUIRY
Abilities necessary to do scientific inquiry
Understanding about scientific inquiry
PHYSICAL SCIENCE
Motion and forces
Transfer of energy
SCIENCE AND TECHNOLOGY
Abilities of technological design
Understanding about science and technology
HISTORY AND NATURE OF SCIENCE
Science as a human endeavor
Understanding the nature of science

Source: National Science Education Standards

Educational Standards Alignment

National Council of Teachers of English Education Standards

Students will develop an understanding of:

Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.

Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.

Students use a variety of technological and informational resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

Students use spoken, written, and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

Source: National Council of Teachers of English and the International Reading Association

International Technology & Engineering Educators Association Standards

Students will develop an understanding of:

THE CHARACTERISTICS AND SCOPE OF TECHNOLOGY

New products and systems can be developed to solve problems or to help do things that could not be done without the help of technology.

The development of technology is a human activity and is the result of individual or collective needs and the ability to be creative.

Technology is closely linked to creativity, which has resulted in innovation.

THE CORE CONCEPTS OF TECHNOLOGY

Technological systems include input, process, output, and, at times, feedback.

Systems thinking involves considering how every part relates to others.

Technological systems can be connected to one another.

Requirements are the parameters placed on the development of a product or system.

Different technologies involve different sets of processes.

RELATIONSHIPS AMONG TECHNOLOGIES & THE CONNECTIONS BETWEEN TECHNOLOGY & OTHER FIELDS OF STUDY

Technological systems often interact with one another.

Knowledge gained from other fields of study has a direct effect on the development of technological products and systems.

International Technology & Engineering Educators Association Standards

Students will develop an understanding of:

THE CULTURAL, SOCIAL, ECONOMIC, AND POLITICAL EFFECTS OF TECHNOLOGY

Decisions about the use of products and systems can result in desirable or undesirable consequences.

THE ATTRIBUTES OF DESIGN

Design is a creative planning process that leads to useful products and systems.

There is no perfect design.

Requirements for design are made up of criteria and constraints.

ENGINEERING DESIGN

Design involves a set of steps and can be performed in different sequences and repeated as needed.

Brainstorming is a group problem-solving design process in which each person in the group presents his or her ideas in an open forum.

Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.

THE ROLE OF TROUBLESHOOTING, RESEARCH & DEVELOPMENT, INVENTION & INNOVATION, AND EXPERIMENTATION IN PROBLEM SOLVING

Invention is the process of turning ideas & imagination into devices and systems. Innovation is the process of modifying an existing product or system to improve it.

Some technological problems are best solved through experimentation.

THE ABILITIES TO APPLY THE DESIGN PROCESS

Apply a design process to solve problems in and beyond the laboratory-classroom.

Specify criteria and constraints for the design.

Make two-dimensional and three-dimensional representations of the designed solution.

Test and evaluate the design in relation to pre-established requirements, such as criteria and constraints, and refine as needed.

Make a product or system and document the solution.

THE ABILITY TO USE AND MAINTAIN TECHNOLOGICAL PRODUCTS AND SYSTEMS

Use computers and calculators in various applications

Operate and maintain systems in order to achieve a given purpose.

SELECTION AND USE OF ENERGY AND POWER TECHNOLOGIES

Energy can be used to do work, using many processes.

Source: Standards for Technical Literacy, Third Edition, 2007

Educational Standards Alignment

National Council of Teachers of Mathematics Education Standards and Expectations

Students will develop an understanding of:

NUMBERS AND OPERATIONS

Understand numbers, ways of representing numbers, relationships among numbers, and number systems.

Understand meanings of operations and how they relate to one another.

Compute fluently and make reasonable estimates.

ALGEBRA

Understand patterns, relations, and functions

Use mathematical models to represent and understand quantitative relationships.

Analyze change in various contexts

GEOMETRY

Specify locations and describe spatial relationships using coordinate geometry and other representational systems.

Use visualizations, spatial reasoning, and geometric modeling to solve problems.

MEASUREMENT

Understand measurable attributes of an object and the units, systems, and processes of measurement.

Apply appropriate techniques, tools, and formulas to determine measurements.

DATA ANALYSIS AND PROBABILITY

Develop and evaluate inferences and predictions that are based on data.

PROCESS

Problem Solving:

Solve problems that arise in mathematics and in other contexts.

Apply and adapt a variety of appropriate strategies to solve problems.

Communications:

Communicate mathematical thinking coherently and clearly to peers, teachers, and others.

Use the language of mathematics to express mathematical ideas precisely.

Connections:

Recognize and apply mathematics in contexts outside mathematics.

Representation:

Create and use representations to organize, record, and communicate mathematical ideas

Create and use representations to organize, record, and communicate mathematical ideas

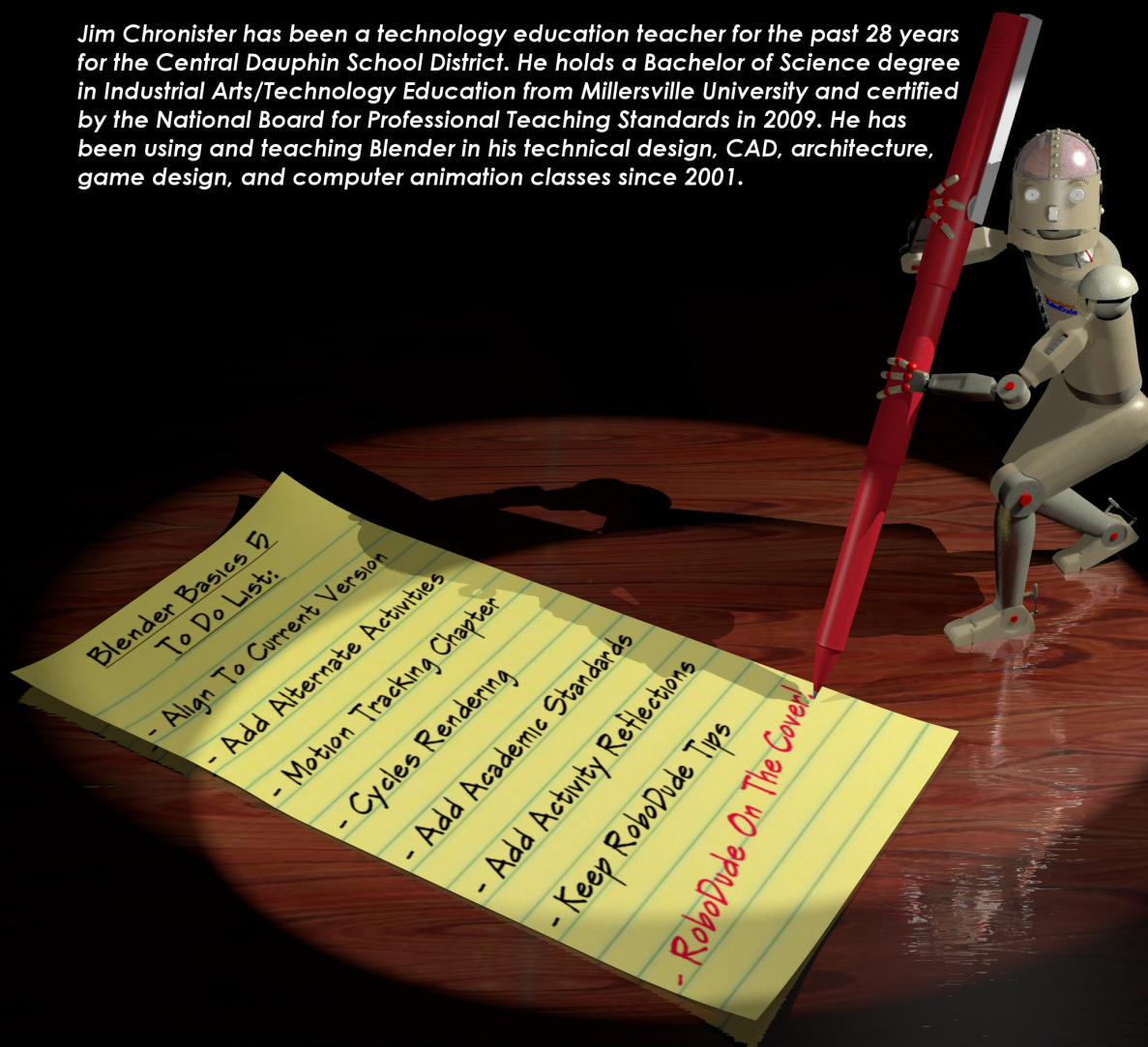**Source: Principles and Standards for School Mathematics**

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About Blender Basics 5th Edition:

Since 2004, Blender Basics has helped thousands of people learn the basics of the powerful open-source 3D modeling, animation and game design program, Blender. The 1st edition was designed as an in-house tutorial booklet for high school students. Since its release on the Internet as a free e-book in 2004, public interest has fueled the book's development as the software continues to grow. The 4th edition reflected the program's complete overhaul in 2011 to become more user friendly and competitive with other commercial programs on the market. This 5th edition aligns the book to the current interface and command changes and introduces some new activities, features, and academic standards alignment for teachers. This book is 266 pages, designed to cover the basics of most of the program's capabilities, and can be completed in as little as 40-50 hours. More information about the Blender program and downloads came be found at www.blender.org. More information and downloads for the book can be found at www.cdschools.org/blenderbasics.

About the Author:

Jim Chronister has been a technology education teacher for the past 28 years for the Central Dauphin School District. He holds a Bachelor of Science degree in Industrial Arts/Technology Education from Millersville University and certified by the National Board for Professional Teaching Standards in 2009. He has been using and teaching Blender in his technical design, CAD, architecture, game design, and computer animation classes since 2001.

Blender Basics 5
To Do List:
- Align To Current Version
- Add Alternate Activities
- Motion Tracking Chapter
- Cycles Rendering
- Add Academic Standards
- Add Activity Reflections
- Keep RoboDude Tips
- RoboDude On The Cover!

Blender Basics is Powered By:

Blender.org   Blendernation.com   Gimp.org   OpenOffice.org   cdschools.org

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